

A
D I S S E R T A T I O N
O N
Q U I C K - L I M E
And
L I M E - W A T E R.

By *C H A R L E S A L S T O N*, M. D.

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Royal College of PHYSICIANS, and Professor of Me-
dicine and Botany in the University of EDINBURGH.

The SECOND EDITION, with Additions.



E D I N B U R G H :

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M D C C L I V.

A

DISSERTATION

ON

QUICK-LIME

AND

LIME-WATER.

By CHARLES WESTON, M.D.

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Royal College of Physicians, and Professor of Me-
dicine and Botany in the University of Edinburgh.

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MDCCLIV.

To the STUDENTS of *Materia Medica*.

AS I promised in the Winter, Gentlemen, I now put into your Hands, one of the Discourses you then heard on the *Simples*, considerably enlarged; hoping it may be of Use to you in your future Practice, especially at Sea.

This Dissertation on Quick-lime, as well as that on Opium published in the fifth Volume of the Medical Essays, clearly shews, how much our Knowledge of Medicines may be improved by a very few easy Experiments. What Discoveries have been made by them on Quick-lime, you have here; and how much the History and Effects of Opium have been illustrated by them, you cannot have forgotten. However,

It is not amiss to observe, that some things taken notice of, and clearly proved in that Dissertation, and there first, so far as I can yet find, have been remarkably confirmed by later Experiments, particularly the Action of Opium on the Nerves to which it is applied. Ab Opii gr. iv. Clysmati additis, æternum dormivisse visus est æger. Vid. Gaubii lib. de form. p. 374. And Dr Whytt found, that although a Frog continued moving its Limbs, turning from Back to Belly, and leaping about for above an Hour, after he had cut out its Heart, and was not quite dead after two Hours and a half; yet having injected a Solution of Opium into the Stomach and Guts of another Frog, five Minutes after having taken out its Heart, in less than half an Hour it seemed to be quite dead; and neither pricking, tearing, nor cutting its Muscles, caused any Contraction in them, or any Motion in the Part to which they belonged. "Since, adds the Doctor, in this Frog, which was deprived of its Heart, the Parts of the Opium could not possibly be mixed with the Mass of Blood, or be conveyed along with it to the Brain; their Effects must necessarily be deduced from their direct Action upon the Nerves and Fibres of the Organ to which they were immediately applied." Vid. Essay on vital Motion, p. 375.

EDINBURGH, Oct. 24.

1752.

P R E - H

P R E F A C E.

I Have in this Edition added a few Notes, to illustrate or confirm some Passages in the former; and answered such Objections as, in my Opinion, deserved a Place in it. But there being several Things, of some Consequence to the Subject, which were either designedly omitted in the Discourse, or came to my Knowledge too late to be inserted, a short Account of them here, I hope, will not be unacceptable to the Reader. And it well deserves to be noticed,

1. That, although it cannot be allowed, that fixed alkaline Salts precipitate the calcarious Matter, or earthy Part of Lime-water; yet there is a Substance, more nearly allied to it than any Salt, which seems to do it effectually; I mean the *Magnesia alba*, or that alkaline Earth which is the *Basis* of Sea-salt. This I owe to *Jos. Black*, M. D. (a); who found, that 200 Grains of his *Magnesia alba* reduced 126 Ounces, or 56,188 Grains of Lime-water, to pure insipid Water; while the Weight of the well-dried *Magnesia* was increased to four Drams and thirty-five Grains (b).

Hence the Lime contained in 126 Ounces, or about thirty-one Gills, of Lime-water, amounts only to seventy-five Grains, although it would have yielded about ninety Grains of Crusts: Which confirms what I learned from other Experiments long ago, viz. That the Quantity of the Crusts which Lime-water affords, considerably exceeds the Quantity of Quick-lime dissolved in it (c). But to know whether the Heat of boiling Water was necessary to the Success of the Experiment, and what Time it required,

(a) Vid. Diff. p. 62.

(b) *Magnesia* in pulverem subtilem redacta, drach. iii. scrup. i. in phialam indidi unc. iv. fere capacem; hanc aqua calcis implevi, optime obturavi, & aqua dein ferventi fovi. Aqua calcis cito omnem penitus perdidit saporem, inque aquam puram conversa est. Hanc itaque effudi, novam addidi, in eodem calore reposui, opusque iteravi, donec aqua calcis lib. vii. unciasque xiv. jam affudissem; tunc vero recens affusa, saporem suum non amplius amittebat. *Magnesia* dein optime exsiccata, pendebat drach. iv. scrup. i. grana xv.

(c) Vid. Diff. p. 8. & 9.

2. I put a Dram of *Magnesia*, prepared by myself of Epsom Salt, as it is commonly called, into two Gills of cold Lime-water, in a Glass Bottle, shaking it now and then; and in less than three Hours it was insipid, and dissolved Soap like common Water; and was of the same specific Gravity, weighed in a Glass Flask. All that was clear being poured off, I added more, shaking the Bottle as before; and thus prosecuted the Experiment without Heat, as far as the Doctor did with Heat; and it answered in every Thing, excepting the Weight of the *Magnesia*, when fully dried. I infused also, at Nine in the Morning, another Dram of the same *Magnesia*, in nine Gills of Lime-water; and at Twelve the Taste was sensibly altered, at Four much weaker, and at Eight in the Evening insipid. But the *Magnesia* well dried, weighed only seventy Grains. So, according to this Experiment, “there is
“not one Grain of Lime in three Ounces and a Half
“of Lime-water (*d*).” But perhaps my *Magnesia* was not so fully washed as Dr Black’s. However,

Since the *Magnesia* can sweeten more than 280 times its own Weight of Lime-water, and there is no Reason to fear that any bad Quality can be communicated to the Water by it; here is a short Way of fitting it for any Use, to which the common Element is applied at Sea (*e*). If indeed only one Pound of Quick-lime be taken for a Hogshead of Water, which probably is enough to preserve it, five or six Months, from Vermin and Putrefaction; the Water, by the Motion of the Ship, and Influence of the Air, may, in a shorter Time, so free itself of the Lime, as not to need the *Magnesia*. But when so much Quick-lime is infused as shall be found necessary, in long Voyages, to keep the Water fully impregnated, by the Help of the *Magnesia* it may be sweetened at any Time.

3. Although as strong a Caustic as can well be wanted, may be made of the Lixive of one Part of Quick-lime, and two Parts of Potash (*f*); yet it is not thence to be inferred, that it is fully as corrosive as when e-

(*d*) Vid. Diss. p. 9.

(*e*) Vid. Diss. p. 33.

(*f*) Vid. Diss. p. 23.

qual Parts of each are taken; the Quick-lime and Potash being the same in each Preparation: For I found, that a Ley made of equal Parts of Potash and Quick-lime, dissolved, in the same Time, much more of a Fragment of a very hard *Calculus* into a white Mucilage, than one made with Half the Quantity of the same Lime; as this was also much stronger, than when a fourth Part only was employed; their Strengths being nearly as 28, 15, and 9. But great Regard ought to be had to the Quality of the Potash, as well as Quantity of the Lime; some containing four times more undissolvable Stuff than others.

4. It is said, *Diff. p. 73.* that the Fragment B of a *Calculus* continued solid for several Months, and never fell down, as did A, to wit, till it was taken out: which is true also of the second Experiment; but the third was not then compleat. For the Fragment of the same *Calculus*, put into Stone Lime-water the 21st of *March* last, on the 8th Day of *July* had undergone the same Change that A did; that is, about six Weeks later. And to discover whether common Water could make any Impression on this hard *Calculus*, *July 24.* I put Half a Dram of it, in two Fragments, into six Ounces of Water, taking little Notice of them for two Months: But, towards the End of *September*, I found them not only covered with the white Grains (g), but also a considerable Quantity of white Sediment by them, which I did not expect.

5. In the *Phil. Trans.* vol. 48. p. 163. we find a learned Author writes thus. “With a design to find out
“how long I could keep Fish and Flesh fit to eat in
“Lime-water, I put two Haddocks, and a Pound of
“Beef, in different Pots full of Lime-water, and cork-
“ed them well. They stood in our Cellar eighteen
“Days. I then took out one of the Fish. It was sweet,
“sound, and firm. I boiled one Part of it, and broil-
“ed the other: It eat well, and had not the least
“Taste of Lime-water; but was not just so firm as
“a fresh Fish. But when I opened the Beef-pot, to
“my great Surprise, it stunk abominably. I poured

“ the Lime-water from both Pots, and put in fresh
 “ Lime-water. This stood four Weeks longer. The
 “ remaining Fish was quite fresh, and a little swelled;
 “ but when I boiled it, dissolved to a Jelly. The
 “ Flesh was very putrid. Thus Lime-water appears to
 “ preserve Fish, but not Flesh. Dr *Alston*’s Experiment
 “ was made with Fish, and Dr *Pringle*’s with Flesh;
 “ which has made the former say, that Lime-water
 “ withstood Corruption strongly; and the latter, that
 “ it did it but weakly, if at all.” Then follows a
 Letter dated *April 6. 1753*, which begins and ends
 thus. “ I lately repeated the Experiment more fully,
 “ and with the same Success.—All this you have my
 “ Leave to shew, as a Confirmation of the former Ex-
 “ periment.”

But since no Antiseptic can withstand Corruption, where it has no Access, or cannot penetrate in sufficient Quantity, his Experiments are faulty, on a double Account; the Beef being in too great a Lump, and the Quantity of the Lime-water too small. Had he minced his Beef, and taken enough of Lime-water, he would have found his Flesh eat as well as his Fish; which he long ago owned, and ought to do it also publicly. But how he excuses his asserting, that my *Experiment was made with Fish*, I know not: For the very first Experiment adduced to prove this antiseptic Virtue of Lime-water, was made with a little Bit of fresh Beef; another with Beef-brine; a third with *Serum sanguinis*, &c. (*b*). Whoever therefore will repeat such Experiments, let them observe the Directions in the Note at *p. 36.*: and if half-inch-thick Pieces putrify in a Week or two, which may perhaps happen, they ought to be cut smaller; remembering always, on account of the Influence of the Air on Lime-water, that they be made in close Vessels.

6. A very great and good Man informed me, that eighteen Gallons of *Thames* Water, in which he had put the Proportion of a Pound of Chalk-lime to a Hog-head, became putrid and fetid, as soon as that which had none in it, and continued so for four Months,

when he threw it away; that when he put in the Proportion of eight Pounds to the Hogshead, the Water did not stink, but had a more detestable offensive Taste than stinking Water; and that of four Gudgeons laid in strong Lime-water, in a Week one was too foetid to eat; and at four Weeks end, one being boiled, it was so very putrid, as to have its Flesh dissolved into minute Fragments and Particles.

As for the Cause of the Putrefaction and offensive Taste of *Thames* Water, see Note (o). p 14. For if it was not owing to the uncomplete Calcination of the Chalk, or to the Lime's not being sufficiently mixed with the Water, or to the Beer vessels wherein the Experiments were made; there must be something in that River more putrescent, than is to be met with in the most foetid Water about *Edinburgh* (i). But whatever is in this, if Lime-water can be made of the *Thames*, I am much mistaken if less than eight Pounds of good Quick-lime will not suffice for an Hogshead: And though more should be necessary, it can easily be got, and either infused in the Water, or carried dry, but slaked, to Sea; where it may be useful on several Accounts. Particularly, since the Attempt to sweeten Sea-water is renewed (k), it is not improbable, considering the Effect of Quick-lime on urinous Salts, &c. that it may supply the Place of Mr *Appleby's Lapis infernalis*, and calcined Bones; and some Experiments which I made, with Sea-water, distilled by my Friend Dr *Archibald Hamilton* both these Ways, confirm the Conjecture. That from Quick-lime, neither precipitated a Solution of Silver in *Aqua fortis*, nor a Solution of corrosive Sublimate in Water: Nor did this last Mixture form a Pellicle of various Colours on its Surface, as did the Water distilled by Mr *Appleby's* Process.

That Lime-water made with Shells or Chalk has sometimes a very abominable Taste, yea and foetid Smell too, I readily own: For I have been obliged, once and again, to throw them away on that very Account, even after five or six long Calcinations; which

(i) See Diss. p. 37. No. 6. *sub finem*.

(k) Vid. Boyle's Works, vol. 4. p. 160. vol. 5. p. 199. *Phil. Trans.* vol. 48. p. 69.

Stone Quick-lime never needs. Had this been adverted to, and the Experiments always made with Stone Lime-water sufficiently impregnated, not a few Mistakes concerning the Strength and Effects of this Fluid had been prevented.

Whether Gudgeons are more difficultly preserved than Herrings or Haddocks, I know not (*l*); for perhaps too little Lime-water was taken, or the Experiment defective, on some other of the above Accounts. If animal Substances infused some Weeks in Lime-water, are commonly tenderer than when put into it, this makes it still the more useful, on several œconomical, as well as medicinal Accounts; because by it hard, dried, tough, and salted Meats, may be rendered more soft, sweet, and easily digestible; and Milks also more nourishing and wholesome, even in Consumptions. Sure I am, that no Liquor ever agreed better with my Stomach than Lime-water, which is still my common Drink, though in perfect Health. But,

7. In answer to Art. 38. of the *Monthly Review* for Oct. 1753, I need only desire the Authors to read the Dissertation: For if they had ever done it, they certainly would not, 1. have cited out of it what was never in it; *ex. gr.* That *Earth-worms immediately threw out a great deal of Slime, and became as yellow as Saffron*; that *Antacidity is ascribed to Lime-water*, on somewhat equivocal Phænomena; that in explaining the Action of Lime-water on marine Salts, *it is considered as an Antiscorbutic*; that it is made, *without Distinction, a considerable Antiscorbutic, &c.*; nor, 2. drawn false Consequences from it; as, because it tastes notably salt or muriatic, it must therefore act like Sea-salt; and to be consistent, Salt must be made, at least, not bad for the Scurvy; because it may probably be useful in Sea-diseases, therefore the Sea-scurvy must be intended as a principal one, &c. Need I mention any of their learned Criticisms? as, That a grating Acid in the Stomach might arise from a biliose or alcalious Stimulus; that some of the Insects may be considered as simply drowned; that it corrects marine Salts—is easier to say than

(*l*) See Note (*c*), p. 36.

demonstrate; that the Doctor has not adduced a single Case in Point in Sea-scurvies? &c. And,

Lastly, As I shall always be ready to own and correct a Mistake, so soon as I discover it; so if the Inference from Dr *Hales's* Experiments, *Diff.* p. 19. deserves to be called one, as Dr *Whytt* thinks it does, the Occasion of it may be seen in a Note on p. 65. of the Dissertation. But that Soap-leys contain a considerable Proportion of Lime, cannot be doubted: For in boiling it down to a third or fourth Part, the Lime visibly subsides, like small white Sand, as well as when it is evaporated to Driness, and dissolved again and again in Water. Thus I have got from four *Troy* Ounces of a weak Soap-ley, about three Drams of dry Salt, and thence twenty-nine Grains of Lime, which is very near a sixth Part, though only twice dissolved: whereas the same Quantity of a strong Solution of the Potash, used in the Soap-work at *Leith*, treated the same Way, yielded nothing like Lime, but only about five Grains, of a light Earth, though there were of dry Salt five Drams and a half on the first Evaporation.

I shall only add, That since Quick-lime and Salt, in a red-hot Crucible, neither gave Flame nor Smell, nor did Galls give Lime-water a blue Tincture, in the Trials that I made (*m*); the Existence of a vitriolic Acid in either, is not thus to be proved: far less by any Experiment, that *Calx viva ex crassiore materia pingui glutinosa, nec minus ex substantia terreo-salino-alcalica, et sulphureo-salino-urinosa, constare recte dicatur* (*n*).

EDINBURGH, Oct. 24. 1754.

(*m*) Vid. Mr *Malouin*, Mem. Acad. 1745.

(*n*) Vid. *Cartheuser* Fund. M. M. p. 179. & 188.

E R R A T A.

Pag. lin.

31. 39. for inch, read, half-inch.

55. 17. for more than, read, and but two in.

59. 14. after Lime-water, add, made of one Part calcined Oyster-shells, and five hundred and twelve Parts Water.

72. 22. after Besides, delete to my Friend's two Queries.

A
D I S S E R T A T I O N
O N
Q U I C K - L I M E.

QUICK-lime, as an external or topical Medicine, was known and much used by the ancient *Greeks* and *Romans*; who nevertheless, by reason of its caustic Nature, placed it, with their Arsenics, or yellow and red Orpiment, among the Poisons, and were solicitous only how the Hurt that might be done by it, if taken inwardly, was to be prevented or cured. The Chymists of latter Ages boast of their having discovered a lithontriptic Quality in it, or that some of its Preparations did dissolve the Stone. And *Olaus Borrichius*, in the last Century, says, he found by repeated Experience, that Shell Lime-water dissolved *Calculi* into a Mucilage, if digested in it warm for some Days. But the Publication of Mrs *Stephens's* Medicines of late, has put the Learned on making such Experiments and Observations as have produced more valuable Discoveries; and yet the Subject is not exhausted. Quick-lime has other Qualities, of no less Consequence in Physic, hitherto little known, yea and difficultly believed; but I think demonstrated in the following Pages.

S E C T I O N I.

Quick-lime, or Calx viva, is the Lime-stone, Chalk, Shells, or any other calcarious Substance, so calcined in the Fire, as to grow hot in Water, and with Noise split, and fall down into a Powder, impregnating that Liquor with as much of

A its

its dissolvable Part as it can take up. For understanding this more fully, please observe,

1. That the Lime-stone here, is the *Saxum calcis*, *Agric. Foss. l. 7. p. 637.* *Saxum calcarium*, *De Boot 522.* *Worm. 45.* *Charlet. Foss. 20.* *Lapis calcarius*, *Schrod. 353.* *Lem. Dict. 101.* *Dale 42.* *Geoff. 1. 77.* *Phar. E-dinb. 26.* and a Kind of Marble, but not always of the same Colour or Solidity, nor equally free of heterogeneous Substances. In some Places it has the Appearance of a Bed of Shells, whereof the Interstices and Cavities are filled up with a dark greenish brown Marble, as if, in a liquid State, it had been poured upon them; and takes a fine Polish. Besides this Stone,

2. Several other Sorts of Marble, Alabaster, *Gypsum*, Chalk, Petrifications, Spars, Shells, &c. are calcarious Substances; which may be burnt into Quick-lime, though not all with the same Degree of Heat, or in the same Time. Our Lime-kills burn eight or ten Days, more or less, as the Wind blows less or more favourably. Much less Time suffices for Chalk and Shells; and the Calcination of *Gypsum*, or the Plaister-stone, according to Dr *Lister*, is completed in two or three Hours (a).

Whether the Strength of the Quick-lime is any way proportional to the Degree of Heat, and the Time its Calcination requires; or whether Stone-lime or Shell-lime is the strongest, or rather most strongly impregnates Water, I cannot positively determine (b). By the Experiments which I have made, there seems to be no Difference; but, according to Dr *Whytt*, the Lime-water

(a) Yea in Half an Hour's Calcination, the *Gypsum* which I have, became exceeding white, separated into thin Leaves, and being put into Water, without Heat or Noise, fell down into Lime. But neither then, nor after it had been once and again calcined for four Hours, did it afford any Lime-water.

(b) *Omnia autem hæc magis vera de calce viva saxea, quam de ostracodermatis calcinatis parata.* Boerh. Chem. 2. p. 316. *Utique certissime calx viva, quo acriore usta & diuturniore igne, eo plus caloris, id est, veri ignis, in aqua frigida excitat.* Ibid. p. 65.

of the Stone Quick-lime, is not so effectual in the Gravel, as the Shell Lime-water (c).

3. Why cold Water heats Quick-lime, is a difficult Problem. For the *Antiperistasis* of the Schools has been long ago exploded; *Van Helmont's* lixivial alkaline and acid Salts demolishing one another, is evidently imaginary (d); and the setting at liberty Fire fixed in it, by which not a few of the Learned account for it, did not satisfy the great Mr *Boyle* (e), though he had observed, that two Drams of Calx vive were increased on the Cupel to two Drams twenty-nine Grains (f). And the learned *D. Ludovicus* thus concludes his *Experimenta cum calce viva facta* (g). *An vero ignearum particularum hic conclusarum fuga (ceu a superiori seculo hucusque permultis viris eruditissimis placuit) simpliciorive lucta, aut modificata quadam nutritione (quo Excell. Conringius inclinavit) aliave elementi primi congregatione contingat, determinatu profecto æque adhuc-dum deprehenditur difficile: nec resistentes hinc inde obscuritates satis determinari posse videntur, donec etiam de penitior ignis natura plenius atque planius constiterit aut convenerit.* It is well known, that Spirit of Wine, Oil of Vitriol, Filings of Iron, &c. grow hot with Water; that a Mixture of Iron, Brimstone, and Water, takes Fire of itself; and that the Weight of Lead, Tin, Antimony, is much increased by Calcination. But that a second Calcination should have the same Effect on Calx vive, is truly singular; especially since its Weight is not proportionably diminished, however long drenched in much Water; as will afterward appear. I kept half a Dram of Chalk Quick-lime in a red-hot Crucible, full two Hours; and three Hours after weighed it, when it had neither lost nor gained any thing, but was just half a Dram as before. But granting Fire were fixed in Calx vive, and its grow-

(c) *Vid. Med. Essays*, vol. 5. part 2. p. 156. Edit. 1747.

(d) *De Lith.* c. 3. § 7.

(e) *Mechan. Orig. of Heat*, vol. 3. p. 376. Edit. 1744. fol.

(f) *Experiments about igneous Particles*, *ib.* p. 349.

(g) *Ephem. Germ. An.* 6. Dec. 1. N. 244. *Bib. Pharm.* 1. 449.

ing hot in Water, owing to this Fire's being set at liberty; yet,

4. The Virtues of Lime-water cannot depend on this Fire. For (a) the Heat is soon over; this Fire at liberty soon evanishes, without leaving any other Quality behind it, than it does in boiled Water. Besides (b), if Quick-lime be kept for some Time, or not fully calcined, however recent, it produces no Heat in Water; which nevertheless it will impregnate with all its Qualities, as well as when it does turn it hot; that is, it will make as strong Lime-water, though not so great a Quantity of it, as if it had been fully and freshly calcined. (c) The second Lime-water, where Heat is never produced, is as strong as the first, as will by and by appear. Indeed,

5. It is the common Opinion, that the first Lime-water, or the first Infusion of Calx vive in Water, is much stronger than the second, and the second than the third: Which is mentioned by Mr *Charas* (b), and I think by him only, and that probably on account of the small Quantity of the Water there used; for he orders it to be poured on three or four Pounds of Calx vive, till it stand about five or six Fingers Breadth above it; and the same Quantity of Water to be added a second and a third Time. It has also been generally believed, that, in order to obtain good Lime-water, the Calx vive must not only be recent and fully calcined, but also for one Part of Quick-lime, only eight, ten, or, at most, twelve Parts of Water taken; as if it could impregnate no more. But Experiments have convinced me, that one Pound of fully-calcined and recent Calx vive, may impregnate some hundred Pounds of Water, and as strongly too (so far as I could discover) as it can eight or ten, however paradoxical this may at first appear. For,

6. In *June* 1743, having only some Experiments relative to Vegetation in View, I put into a large inverted Bell-glass between two and three Pounds of our

(b) *Phar. Roy.* p. 818.

common Quick-lime, and poured on it twenty Pounds of Water or thereby. In a few Days I got about ten or twelve Pounds of Lime-water pretty clear. So much of the first Water remaining in the Lime, it was obvious to conclude, that though I threw into the Vessel ten or twelve Pounds more of Water, it would still be Lime-water, somewhat diluted only. But it appearing to be, as strong as the first, I filled up the Bell a second Time. And this third Lime-water not being sensibly weaker than the first, I filled up the Vessel a third, fourth, fifth, and I do not know how many Times, as it needed, for more than two Years; during which Time I watered a great Number of Plants in Pots, with this Lime-water only: And yet in *December* 1745, it had the Lime-water Taste, turned Syrup of Violets green, Vegetable Infusions yellow, volatilised Sal Ammoniac, gathered Crufts on its Surface, was as detergent as ever, and no way inferior to the first Infusion. Nor did it appear sensibly weaker till Midsummer 1746. But soon after, the Lime was quite exhausted, communicated nothing to the Water, and I threw it out. Having kept in a Pot dry, some of the same Quick-lime for these three Years, and which was in Powder, I put about two Pounds of it, or so, into the Bell-glass, to see how much Lime-water it would afford; and, to my no small Surprise, found it could yield none at all, more than it had been clean Sand. This called to Mind an Observation of some of our Country-people, that the Effects of Lime on Land lasted but three Years. But afterwards I found, that wetted Lime retained its Qualities much longer, I mean the Qualities of Quick-lime; for after these are gone or fixed, Lime, or even old Lime Rubbish, much improves sour or stiff Grounds. Being employed still in Experiments on Vegetation, I intermitted these on Lime for a Year; but resumed them the Year following. And on

7. *September* the 2d 1747, I put into the same Bell-glass, three pounds of the common Lime, brought to Town in Powder for building, being flaked at the Lime-kills, and poured on it twenty Pounds of Water; and had

had from it as good Lime-water as from the unflaked Quick-lime, though neither Heat nor Ebullition ensued on the Mixture; and I think I may say a greater Quantity, though I did not use it so fast as the former: for I filled it up with twelve Pounds of fresh Water, five Times the first Year; and how often since, I neglected to note down: But to this Day (*September 13. 1752.*) it continues strong Lime-water still, (*yea June 4. 1754.* it is not sensibly weaker). More exactly,

8. To find how much Water any given Quantity of Quick-lime can impregnate, or how much Lime-water it may yield; I poured on thirty Grains of Calx vive in a China Bowl, two Gills, or seven Ounces three Drams twelve Grains (the Gill containing three Ounces five and a half Drams six Grains, or 29. 8. Drams) of Troy Weight. Two Days after, I filtered from it a Gill of Lime-water, and poured on three Gills of fresh Water, filtering it also two Days after. This I repeated twice; and had in all ten Gills of Lime-water, from thirty Grains of Quick-lime; that is, five hundred and ninety-two Times its own Weight. The fifth Water had nothing of the Lime in it. The Remainder, with the Crusts in the Filter, being well dried, weighed just twenty-two Grains. This must appear another Paradox, but will be explained below. The first Infusion was on the 20th, and the last on the 27th of *February*. Hence, and from N^o 6. and 7. it follows, that Lime retains its Qualities much longer in Water than in the Air, or when wet than when dry; and that Quick-lime may be exhausted of all that Water can extract from it, be washed, or sweetened in a few Days, if a sufficient Quantity of Water be used, otherwise not.

9. I put also into the above Bowl, a calcined Shell of an Oyster, of an Ounce Weight, and filled it up with Water. The Shell was not so fully calcined, as to fall down into Lime. So soon as a Crust gathered on the Surface, I poured off the Water, and filled up the Bowl; and this I did to the thirtieth Time, when the Water became weak, but not quite free of the Lime. The Bowl can contain about an *English* Pound of Water.

ter. Thus an Ounce of a not fully-calcined Shell, yielded about four hundred Ounces of Lime-water, the Bowl not being always quite full. And having filtered and dried what remained, it weighed five Drams fifty Grains, though I saved none of the Crusts. So, to find what Addition they made to the Weight of the *Residuum*,

10. I repeated the Experiment, taking of Chalk calcined in a common Fire sixty-nine Grains, pouring on it three Gills of Water, and filtering it when it had stood a proper Time, to save the Crusts. When I had repeated this seven Times, the last Water was not quite free of the Lime. So even excluding the eighth and last three Gills, I had more than seventy-seven Ounces of Lime-water from sixty-nine Grains of this Chalk Quick-lime; that is, about five hundred and forty times its own Weight. And the remaining Lime with the Crusts well dried, weighed sixty-five Grains, as if there had been but one Grain of the Quick-lime in nineteen Ounces of Lime-water. This must at first Sight appear altogether inconsistent with Truth, Lime-water certainly containing a much greater Proportion of the Lime in it. For,

11. Lime-water, however well filtered, exposed to the Air, in less than a Minute's Time throws up on its Surface a Scum, which soon becomes a thin Pellicle, transparent at first; but in a Night's Time or so, a white, opake, and very brittle Crust, thickening but little afterwards, and never subsiding, unless it be broken. If this Crust be taken off, another will gather, so long as there is any Lime in the Water. For when none appears, the Water has no other Effect on Syrup of Violets than common Water: And as the Crusts gather, the Water becomes weaker. So long therefore as that of which these Crusts are, at least in Part, formed, continues dissolved in the Water, the Lime-water retains its Qualities, or continues Lime-water, and no longer; although the same Crusts, when formed, have nothing of the Nature of Quick-lime in them; which may be reckoned a fourth Paradox. Now,

12. To

12. To find how much of these Crufts Lime-water contains, or can afford, any certain Quantity of it needs only stand a few Days in an open wide-mouthed Vessel, now and then stirring the Water, and breaking the Crufts, until the Water make no Change of the Colour of Syrup of Violets; then filtering the Liquor, and drying the Crufts. Thus, by many repeated Trials on common, Shell, and Chalk Lime-waters, I found (a), that four Gills, or fourteen ounces six Drams and twenty-four Grains of any of them, gave of calcarious Crufts eleven or eleven and a half Grains; that (b) the first Infusion did not give more than any succeeding Infusion; the Lime-water N^o 7. yielding as much as any of them in *June* 1752; at least that the Difference did not exceed half a Grain; which might be owing to the Circumstances of the Air at the Time of weighing them, which was always in the Paper through which they were filtered, which gained or lost so much according to the Moisture or Driness of the Air: and (c) that slaking recent Calx vive in Lime-water, did not sensibly increase the Quantity of these calcarious Crufts. The Lime-water was always filtered through common gray Paper in these Experiments. And lest the Influence of the Air should have weakened the Water during the Filtration, I treated an equal Quantity of unfiltered Lime-water the same Way, and had but eleven Grains and a half of Crufts, as when filtered.

Thus I think the Proportion these Crufts bear to the Water, is with greater Accuracy discovered than it can be by Evaporation; because Water evaporated always leaves some Earth behind it, some more some less; and without making the Experiment by evaporating the Water by itself, it is not possible to determine how much of the *Residuum* is this Earth of the Water. And hence probably it is, that a Pint of Lime-water, by Evaporation, afforded Dr *Langrish* sixteen Grains of a calcarious Substance (i). For even the eleven Grains, or eleven Grains and a half, the most that I could ob-

(i) Vid. Dr *Whytt*'s Essay, l. c. p. 198.

tain from much the same Quantity, very much exceed what the Lime lost in Weight: Which must be owing either (a) to the Water retained in the washed Lime, even after it appeared to be fully dried; or (b) to the terrestrial Parts of the Water united to the Lime-crusts; or (c) to the Air, or something attracted from it. For,

13. No Exsiccation, without Calcination, can drive out all the Water from wetted Quick-lime. Hence I found, that a Dram of Calx vive, though three Waters had been taken from it, when fully dried, weighed sixty-seven Grains, notwithstanding all the Crusts were not preserved. To determine therefore how much Water dried Lime retains, I infused for a Night a hundred and twenty-one Grains and a half of recent Chalk Quick-lime in Water; then filtered and dried the Lime fully, which weighed a hundred and fifty-four Grains; that is, was increased thirty-two Grains and a half, or more than a fourth Part. Now, allowing that of the sixty-five Grains, N^o 10. of the washed Lime, the fourth Part to be adhering Water; this fourth Part being sixteen and one fourth, or call it seventeen Grains, added to the four Grains, which it wanted of the Quick-lime taken, it makes but twenty and one fourth, or twenty-one Grains in all, dissolved in more than seventy-seven Ounces of Lime-water, that is, not one Grain in more than three Ounces and a half. Whereas by Experiments, N^o 12. every three Ounces of Lime-water yielded more than two Grains of calcarious Crusts; that is, more than double the Quantity of Lime that seems to be dissolved in it. And allowing to the Crusts the same Proportion of Water we allowed to the washed Lime, there will still be more than two Grains of calcarious Matter separable from three Ounces and a half of Lime-water, still double the Quantity of the Lime dissolved. One half therefore of these Crusts must come either from the terrestrial Parts of the Water, or from the Air. To discover how much the Air contributed to these Crusts,

14. I calcined in a red-hot Crucible for two Hours

fifteen Grains of this calcarious Matter, which was thus reduced to eleven Grains and a half; so diminished three Grains and a half. I put it again into the Crucible, and set it uncovered in a North Window; and after four Days weighed it again, and found it thirteen Grains and a half; so had imbibed two Grains. This made me suspect, that I had accidentally lost some of it, since probably it could not retain more Water than Quick-lime. Having therefore collected more of these Crusts, I calcined forty-eight Grains of them, and then carefully weighed them, and they were reduced to forty-three Grains; which exposed to the Air for two Days, weighed forty-four Grains. So that in forty-eight Grains of those Crusts, there were only, at most, five Grains of Water; that is, near one half less than Lime retains. Hence either they contained no Air, or Fire could not drive it out. As for Water,

15. It is very certain, that there are few Fluids, with which Lime-water can be mixed, from which it does not precipitate something. It precipitates a Solution of Alum, of Borax, of common Salt, of Vitriol, of every volatile or fixed *Alkali*; every vegetable Infusion; Urine, Bile, and other animal Fluids; Wines, hard Waters, our Fountain-water, yea and aromatic distilled Waters, and tinctured Proof-spirits too. I observed no Precipitation, on mixing it with acid Spirits, nor with a Solution of Nitre. That terrestrial Substances are in Water, in some more, in others less, is evident, not only by the many lapidescent Springs, but also by the stony Crusts, with which the inner Surface of Vessels, wherein Water is commonly boiled, for Instance Tea-kettles, is soon covered. If from this earthy Substance a considerable Part of the calcarious Crusts formed on the Surface of Lime-water is derived, as probably it is, Lime would appear to be a notable Purifier of Water, as it is of many other Substances, and to diminish its specific Weight: But by any Experiment I could make either with a Glass Ball, or by weighing in a thin Glass Flask, the Lime-water, after it had freed itself of all the Lime, was neither specifically

cally heavier nor lighter than the Water of which it was made; though a Flask containing thirty-four Ounces and a hundred and five Grains of common Water, contained thirty-four Ounces and a hundred and twenty-five Grains of Lime-water. Nor could I observe any Difference betwixt the first and the tenth or twentieth Infusion. Hence the Lime increases not the Bulk of the Water in which it is dissolved. I am very sensible, however, how difficult it is to determine specific Gravities accurately (*k*).

16. Although Lime-water exposed to the open Air, soon frees itself of all the Lime; yet in a well-corked Bottle it will keep good I do not know how long. I have a Bottle of it twelve Months old, which still tastes of Lime-water, and greens Syrup of Violets, though I frequently opened the Bottle, and tasted the Water, during that Time. The Air has also considerable Influence on Calx vive itself; in Time fixing it, or quite altering its Nature, and rendering it incapable of communicating any thing to Water, more than Chalk or any absorbent Earth. How soon the Air will thus fix it, if spread out thin, I have not tried; but probably not so soon as is commonly imagined. For I have made good Lime-water of two Years old Quick-lime, and never found it fixed in less than a Year; and probably in a Bottle it might be kept much longer. But when thus fixed, as well as when all that Water can dissolve is separated from it, it is as unfit for Mortar as for Lime-water (*l*).

17. From

(*k*) *Vid.* Phil. Transf. No 488. Boyle Med. hydrost. vol. 5. p. 22. &c.

(*l*) For the exhausted Lime, No. 6. when dried, did not cohere. But slaked Lime, more than ten Months old, well kneaded with Water, became harder than Chalk, somewhat sounding, and did not fall down in Water. Mixed with some small Sand, it became solid also, but not sensibly harder than the former; and so they still continue. Recently-slaked Quick-lime, treated the same Way, had the same Appearances at first: But in a few Weeks, first, that with the Sand, then the other, cracked in some Places; and being put into Water, that without Sand split into small Bits, and some of it into

17. From the above Experiments and Observations, I think may be inferred, (a) That Quick-lime consists of a dissolvable and an undissolvable Part in Water, scarcely one third Part being dissolvable; that is, of three Ounces of Quick-lime, scarce one Ounce is thus dissolvable. (b) That it is but a very small Quantity even of the dissolvable Part of Calx vive that Water can take up; one Part of Calx vive being sufficient for five or six hundred Parts of Water; that is, one Part of what is dissolvable, for fifteen or eighteen hundred Parts of Water: So one Pound of good Calx vive, is enough to impregnate an Hogshead of Water; and how much more, if made in a close Vessel where no Crusts are thrown up, I know not, but certainly not a little. (c) That Lime-water made with fresh-made Calx, is not stronger than what is made with it, after it is kept some Months, if sufficient Time be allowed the Water to impregnate itself: Nor can its Strength be increased by slaking new-made Lime in it; because it can take up no more of the Lime than it had before. For otherwise Water (suppose a hundred Pounds of it on a Pound of Calx vive) standing many Days, would be stronger than when it stands but a few Days, which yet it is not; though the remaining Lime will impregnate equally as much fresh Water several Times. And (d) that Quick-lime flaked, as is commonly done at the Lime-kills, is better for the Land as a Manure, than the Quick-lime in Stones, or Shells, as it is called; the imbibed Water, in some measure, keeping out the Air. And for the same Reason, the sooner the Lime is tilled down, and mixed with the Earth, it is so much the better.

Powder; while the other cracked in one new Place only. Whether this was owing to the Sand, or to a greater Quantity of Water, by Accident used in kneading it, I cannot determine; neither whether the binding of Lime is more owing to the Sand, or to what Workmen call *souring* it. The Effect of Sand in Mortar, Mr *Maquer*, in his *Elem. de Chym.* p. 65. calls one of the most singular and difficultly-explained Phænomena. Perhaps Sand may have the same Effect on Lime that Hair mixed with it has.

18. According

18. According to *D. Ludovicus, l. c.* the Lime-stone loses more than one Half of its Weight, when fully burnt to Quick-lime. I found, that Chalk lost above a third by Calcination in a common Fire: But how much Oister-shells lose, cannot easily be determined, they split and throw off so much of their *laminæ* in the Fire.

19. *Dioscorides (m)* directs how to make Quick-lime of Sea Shells, thus. Cover them, says he, with Fire, or put them into a burning Furnace for a Night. Next Day, if they be very white throughout, take them out; if not, burn them again, until they become so. Then having slightly dipt them in cold Water, put them into a new earthen Pot, covering it well with Cloaths, and let it stand one Night more; and next Morning, all being exactly done, put it up for Use. He adds, It is also prepared of some Sea Stones burned, and of common or base Marble, which is reckoned the best: And concludes, after giving the Virtues, with observing, that recent or newly-made Calx vive, which has never been wetted, is esteemed the strongest. By these Directions any body may make Quick-lime of Shells or Chalk. I know Mr *Lemery (n)* is pleased to say, "that if, after Lime-stones are once red-hot, the Fire be not kept up, but the Heat suffered to abate, before they are sufficiently calcined, no subsequent Calcination can reduce them to Quick-lime." But this is certainly a Mistake. For it is the common Practice at the Lime-kills, to recalcine such Stones as do not fall down into Lime after the first Calcination; which never fails to reduce to Quick-lime all that is calcarious in them. And Shells seldom being, in a Chamber-fire, sufficiently calcined in four or five, yea in eight Hours, so as, with Heat and Noise, to fall down in Water, I commonly recalcine once, and sometimes twice or thrice, such half-burnt Shells, before they thus fall into Lime.

(m) l. 5. c. 133. p. 379.

(n) Chym. p. 381. & Dict. p. 101.

But if not sufficiently calcined, they give a very bad Taste to the Water (o).

20. Whether any Salt can be got from Quick-lime, is controverted still. *Zwelfer* (p), *Hoffman* (q), *Lemery* (r), *Geoffroy* (s), stand for the negative; *Van Helmont*, with some other Chymists, are for the affirmative: And Mr *du Fay* (t) gives two Processes, whereby he got, he says, a true neutral Salt from it. But the Academy in Hist. 1732. observe, that these Operations not succeeding with other Chymists, they doubted of the Existence of this Salt; and the Discovery was difficultly believed. Whereupon Mr *du Fay* gave a third Process, by which he got from Calx vive one Pound, decocted in twelve Pints of distilled Water once and again, decanted and evaporated to Driness, ten Grains of an acrid caustic Salt: And by using more Water, and not distilled, he got of Salt two Drams wanting two Grains. How the Chymists have relished this Process, I have not heard (u). That Lime, by means of any Acid, which it may obtain from the Air or other Substances, may acquire a saline Form, is not to be

(o) And because this has often happened, even after I had calcined, for eight Hours, Oister-shells, especially such as had lain long on the Shore, on the Land, or among Rubbish, and some Kinds of common Chalk, I soon learned to infuse them, first, for a Day in Water; and if the Taste had any thing of that abominable *Empyreuma*, to recalcine them till quite free of it, before I made use of them for Lime water: Whereas the freshest Shells, and the lightest and most friable Chalk, in a strong Fire, may be calcined sufficiently free of the *Empyreuma* in six or eight Hours Time. The Reason of this I do not comprehend, if it be not owing to their being impregnated with Salts, vitriolic perhaps or urinous, which hinder much the thorough Calcination of all calcarious Substances; as appears by Mr *Maquer's* Experiments. *Elem. de Chym.* p. 68.

(p) Ph. Aug. 279.

(q) In Schrod. Manget. 216. Edit. in fol.

(r) Chym. 383.

(s) M. M. 1. 79.

(t) Mem. Acad. an. 1724.

(u) Mr *Malouin* gives it a vitriolic Salt. But Mr *Maquer* thinks it more probable, that no Salt enters the Composition of Calx vive. *Elem.* p. 67.

doubted;

doubted; but that of itself it contains a Salt, seems not to be very probable. For,

If there is any Salt in Quick-lime, it must be a fixed Salt, having undergone such a Degree of Calcination; and consequently dissolvable in Water, and easily obtained by Evaporation. But all that Water dissolves of Calx vive, is nothing but Lime, or a subtil terrestrial Substance; and when this is separated in the Form of Crusts, which are absorbent, the Water differs nothing from pure Water; or if the Water be driven off by Evaporation, the very same earthy Matter only is left behind; the Water in either case neither containing Salt, nor partaking in the least of the Nature of Lime-water. I have indeed seen several small and beautifully-feathered crystalline or Salt-like Bodies, formed on the Sides of a Phial wherein Stone Lime-water (made of a Pound of Quick-lime, after it had afforded between five and six hundred Pounds of Lime-water) boiled down to a fourth Part, had been some time kept; also in another Phial wherein a Fragment of a *Calculus* had been infused, in the same Lime-water, for two Weeks only. I have observed them likewise in Chalk and Shell Lime Waters, in which Fragments of a *Calculus* were also some time soaked, in smaller Quantities. This crystalline Substance when dried retains its Figure, but becomes white and opake, but not so brittle as the Crusts. I can discover no Taste in it. I got two Grains of this Substance from a Gill of Lime-water, in which twenty Grains of a *Calculus* had been eight Months infused. It did not dissolve in boiling Water, nor give it any Taste. Yea, it difficultly dissolved in diluted Oil of Vitriol; so not a Salt, and yet somewhat different from the Crusts. *Ad calcis salem, spiritum, tincturam, vel oleum quoddam eliciendum, multum insudarunt chymici; sed incassum: si quid enim hujusmodi extraxerunt, non tam a calce quam ab adjunctis educebatur.* Geoff. M. M. 1. 78.

S E C T. II.

Quick-lime is absorbent, antacid, detergent, and caustic.
so

so not to be taken inwardly in Substance; but it is a principal Ingredient in several potential Cauteries, and in many Soaps.

That Quick-lime comes by these Qualities entirely from the Fire, is pretty evident; and I think also, that it is more than probable, that they neither depend on any Salt, nor on actual Fire fixed in it; nor on any more active or more volatile Matter than is the Quick-lime itself; but are the necessary Consequence of the Change made on its Parts by the Fire (*x*). For the better understanding the Nature of this Substance, it is not amiss further to notice,

1. That Quick-lime is too acrid to be tasted; but if sufficiently weakened or diluted, its Taste is much akin to that of lixivial and urinous Salts; it has no Smell, unless mixed with ammoniacal or animal Salts. Moistened, and applied to the Skin, it inflames and corrodes it; yet the Skins of dead Animals steeped several Days in Lime-pits, are not corroded, but only freed of the Hair, and adhering Fat. One of the Ways of preserving Birds recommended by the very learned and curious Mr *Reaumur*, is by stuffing and covering them, either with unslaked or slaked Lime (*y*) (*z*). Hence not only the Taste and Smell of Quick-lime seems to be owing more to the Change it makes on animal Salts, than to the Substance of the Calx vive, but even its Corrosion also. *Corrosio violenta* (says *Boerhaave*) *quæ contingit in corpore viventis, a calce viva illi applicata, magis pendet ab igneis salinis spiritibus, quos calx viva parit de sale prius non acri, quam ab ipso corpore calcis rodente* (*a*).

2. Quick-lime, whether unslaked or slaked, makes an Ebullition, or effervesces with, and destroys vegeta-

(*x*) In which also two eminent Chymists, Mess. *Stahl* and *Maquer*, are agreed. See *Mag. Elem.* p. 70. 71.

(*y*) *Phil. Trans.* N. 487. p. 313.

(*z*) In *March* 1753, I buried in slaked Lime a Piece of Veal; and in ten days it became as dry and hard as a Mummy: It had the same Effect on Beef. And both continue as hard as ever.

(*a*) *Chem.* 2. p. 316.

ble as well as mineral Acids: And I have once and again observed, that flaked Lime dissolved in Spirit of Vinegar, discovered, if I may use that Phrase, a notable Propensity to a Kind of Vegetation, shooting into pretty curious Figures, very white, not a little resembling some Mosses, and making the Glass in which they grew, appear like a little artificial Grotto.

3. Quick-lime is a very powerful *Menstruum*, dissolving all Sorts of Oil, Grease, Gums, Rosines, Brimstone, animal calculous Concretions, &c. some of which cannot be dissolved by lixivial Salts. *Rasura casei* (says *Van Helmont*) (b) *cum arida calce viva liquescit, non autem cum alcali cinerum*. This did not succeed with me in the common Air, without the Assistance of Water. Mr *Geoffroy* (c) observes, that if Oil Olive, or any other *Huile grasse*, be distilled on *Calx vive*, it becomes much thinner, and, like essential Oils, dissolves entirely and disappears in Spirit of Wine. “Whereas the vegetable Oil (says Dr *Hales*) (d) yields to the fixed alkaline Salt of Potash alone, the animal Oil requires the united Force of Lime and Potash.” And the *sulphur præcipitatum Ph. Lond.* or *lac sulphuris*, is prepared with *Calx vive*. Hence it does not corrupt or destroy Oil, though it dissolves and purifies it. *Vid. Sapo infra*, N 16. (a).

4. How much Quick-lime increases the dissolving and corrosive Quality of fixed alkaline Salts, is commonly known. The great *Boerhaave* on the Process of the *sal acerrimus alcalinus igneus cum calce viva*, remarks thus. *Sal hic ex calcis virtute ignea, vere attracta in alcali fixum igneum, acquisivit virtutem rodendi acutissimam, promptissimamque, quæ neque fuerat in alcali solo, neque in calce viva sincera. Hæc acrimonia omnia salina nota superat.* And below: *Sal hic, hac præparatione, acquirit hanc singularem proprietatem, ut evadat aptissimus uniri cum oleis, tam pressis quam stillatitiis, animalium vegetabiliumque, in saponem:*

(b) De Lithiasi, c. 3. § 8.

(c) Mem. Acad. 1741.

(d) Exper. & obs. p. 7.

quippe videtur adeo reddi penetrabilis, ut olea hæc intime dividat, sibi que adunet; quod absque acri hac calce vix commode fieret. Ut etiam, sine calcis ope non flueret tam facile ad ignem alcali, sed funditur quam difficillime (e). Mr Homberg has observed, that Rock Crystal cannot be melted, either by Fire or by the burning *Speculum*, unless it be mixed with Lime, though Lime by itself be as little fusible as Crystal (*f*). Thus Lime seems to impart to other Bodies what it has not itself; a Quality not easily accounted for, nor shall I attempt it. Perhaps the following Experiments may throw some Light on its Action on alkaline fixed and volatile Salts.

5. I dissolved an Ounce of what is called *Pearl Potash*, in three Gills of boiling Water; next Day filtered it through gray Paper; and the *Residuum* well dried, weighed just forty-three Grains. But when two Ounces of this same Potash, and as much pretty recent Stone Quick-lime, were infused in ten Ounces of boiling Water, and after two Days Maceration filtered; the *Residuum*, washed once and again, to carry off what Salt remained in it, and well dried, weighed two Ounces six Drams and forty Grains. Whence deducing a fifth Part for the Water adhering to the Lime, which is four Drams and thirty-two Grains, there remain two Ounces two Drams and eight Grains undissolved; and consequently one Ounce five Drams and fifty-two Grains only, were extracted, by Water, from two Ounces of Potash, and as much of Calx vive; that is, forty-two Grains less, than Water would have dissolved, of the Potash by itself.

I also poured four Gills of cold Water on three Ounces and six Drams of Quick-lime, and three Ounces and a half of Potash mixed: And proceeding as above, found that the cold Water dissolved of this Mixture (being in all seven Ounces and two Drams) three Ounces and half a Dram, (there remaining undissolved four Ounces one Dram and a half); which is

(e) Chem. 2. p. 61.

(f) Lem. Dict. p. 178.

one Dram less than hot Water would have dissolved of the Potash by itself. So cold Water dissolved as much of this Mixture proportionally, as hot Water did of the former.

These two Experiments agreeing so well, it may be asked, Whence comes that Quantity of Lime found in Soap-leys? which, according to the Experiments of the learned and accurate Dr *Hales*, amounts to more than a third Part of the dry Salt obtained by Evaporation from these Leys (*g*). Whilst the learned Chymist Mr *Geoffroy*, whom he quotes (*h*), seems to exclude *Calx* out of the Composition of *Alicant* Soap altogether, if not included in the Salt. For, according to him, "In 180 Pounds of Soap, there are 50 Pounds of Salt of Kali, 115 Pounds of Oil of Olives, and 15 Pounds of a watery Humidity." The Action of *Calx* vive on lixivial Salts noticed below, may help to clear up these Difficulties.

6. In order to discover what Change the Potash had made on the remaining washed Lime, I infused seven Drams of it in three Gills of Water; and found it could draw very little from it, scarcely tasting of the Lime; which being again dried, wanted not a Grain of seven Drams, its former Weight (*i*). So that four Gills of Water, with three Ounces and a half of Potash dissolved in it, either extract from three Ounces and a half of Quick-lime, more than fifty times that Quantity of Water could do, without the fixed Salt, or fixes it; the Lime not being proportionally, in Appearance, diminished. Again,

I mixed a Spoonful of a not very strong Solution of Potash with three Spoonfuls of Lime-water: The Mixture instantly became white and turbid; soon precipitating a white Powder; which being separated by Filtration, and dried, weighed three Grains. The quite

(*g*) *Vid.* Exper. & Obs. p. 8.

(*h*) p. 12.

(*i*) Nor could I, by recalcining it, turn it again into Quick-lime, so as to impregnate Water.

clear filtrated Liquor, mixed with eight Spoonfuls of Lime-water, became milky as before. I filtered it fine, and added to it again a Gill more of Lime-water; which had the same Effect. This being filtered also, I added to it another Gill of Lime-water, which made it as white as ever. I filtered it likewise; and having dried what remained in the Paper, it weighed eleven Grains. The clear Liquor felt very smooth or soapy, and made no visible Ebullition with Spirit of Vitriol; but mixed with Lime-water, it became as milky, and precipitated as plentifully in Appearance as at first.

That the Precipitation was chiefly from the fixed *Alkali*, I think more than probable; because the three Grains of the first Precipitation was more than double the Quantity of Lime contained in the three Spoonfuls of Water. Again, two or three Drops of Lime-water falling into a Glassful of a Solution of Potash, turns indeed white at first, but divides, and soon disappears; the small Precipitation being absorbed, by the much greater Quantity of the *Alkali*: But two or three Drops of a Solution of Potash, let fall into a Glass of Lime-water, not only grow white at first, but continue so, falling to the Bottom in Form of a white Powder. I might add, Lime-water precipitates dissolved volatile Salts; which fixed Alcalies do not, as will presently appear.

Do not then these Experiments make it also more than probable, that Quick-lime rectifies or acts on alkaline fixed Salts, by separating from them some Part of the coarsest of their Earth, and substituting in place thereof its own most soluble and subtile Part, whereby their Strength, as a *Menstruum*, is considerably increased? Thus, Water assisted by a fixed Salt, may dissolve and retain more of the Calx than could be done by a much greater Quantity of Water by itself, even although the remaining Lime appear to be nothing, or not proportionally diminished; which accounts for a seeming Inconsistency. I said retain; because a Ley made of Potash and Quick-lime, exposed to the Air, does not, like Lime-water, throw up a Scum or Crust,
nor

nor is weakened by boiling; on the contrary, the more it is boiled down, the stronger it is.

7. The Effect of Calx vive on volatile Alcalies is no less remarkable. That it should set at Liberty the volatile Spirit of Sal Ammoniac, has nothing singular in it; since this can be done by Chalk, and such like Absorbents: But that the volatile Spirit distilled from Sal Ammoniac, or Urine, with Quick-lime, should be more acrid, more volatile, and yet not alkaline, nor reducible to a saline or solid Form, is the peculiar Effect of the Quick-lime (*k*). *Cum hinc inde ab authoribus* (says the learned Zwelfer) *calcem vivam tantopere ad fixationem salium volatilium deprædicatam scirem, & quod sal ammoniacum figeret (quæ tamen fixatio fucata est, uti expertus sum) frequenter legerem, cum eadem experimenta feci, ipsa salibus volatilibus diversimode, sed secundum artem, addita; ast ne granum quidem illorum, ex prædicta calce, iterum extrahere potui.*—Non tamen destiti ulterius inquirere, eo quod viderem aquam calcis vivæ potentem esse; quin etiam huic aquæ recenti, salia volatilia jungerem; moxque vidi effectum, nimirum salium dictorum totalem destructionem, & eorum in calcem, vel pulverem insipidum indissolubilem, omni odore & sapore privatum, ignisque violentiam in posterum strenue sustinentem, conversionem (*l*).

That Salt of Harshorn dissolves entirely in common Water, every body knows; but it cannot be dissolved in Lime-water, without a considerable Precipitation. I put into half a Gill of Lime-water a Dram of Salt of Hartshorn: It became immediately turbid and milky; precipitating a white Powder; which, being separated by Filtration, and dried, weighed two Grains. The clear Liquor and fresh Lime-water mixed, became again white and precipitated. In a Word, on mixing these two Liquors, much the same *phænomena* occurred, as on mixing a Ley of Potash with Lime-water, related above, N^o 6. I shall only observe, that not only this first Mixture smelled strong of the volatile Salt, and made

(*k*) *Vid.* Boerh. Chem. 1. Procef. 97. & 105.

(*l*) *Ph.* Aug. p. 279. *Vid.* Boerh. Chem. 2. Proc. 105.

a brisk Ebullition with Spirit of Vitriol many Months after they were mixed; but also when so diluted, that there was not a Dram of volatile Salt in fourteen Ounces of Lime-water filtered clear, it made a visible, though small Ebullition with the same Spirit. This precipitating Quality of Lime and Lime-water, and their Action particularly on alkaline Salts, deserve to be further prosecuted than I have yet had Time for.

8. It is to the Calx vive, that the Soap-leys owe their Power of dissolving the *Calculus*, the strongest Solution of any fixed *Alkali* having no such Virtue by itself, as Dr *Hales's* Experiments demonstrate: "Which Solutions (says that learned Gentleman) are probably caused by taking out the animal Oil, which is the Band of Union of the Stones, in the same manner as the whiting of Linen is performed, by taking out of it the vegetable Oil. And as Linen, by being thus deprived of its Oil, is rendered whiter, but has withal its Strength in some measure impaired; so the *Calculus*, in dissolving, generally turns white, whatever be the *Menstruum* (*m*)."
Of this more when we come to consider Lime-water in particular, § iv. And I shall only here observe by the by, that

I am much persuaded, Lime-water, yea and Lime too by itself, with or without Ashes, might be of great Use in bleaching Linens, though it is commonly believed to burn the Cloth [*m*]. For I steeped in Water, with a considerable Quantity of Quick-lime in it, an old Linen Rag, with some coarse Packthread and Linen Yarn, for six Weeks, without their Strength being sensibly impaired: But after other six Weeks, the Rag was somewhat tenderer than at first, but not the Thread. Perhaps simple Water would have had the same Effect. I know only one Objection against the Use of Lime in bleaching Linen; and that is, it gives the Cloth a reddish or brownish Cast, not a clear white. But this Whiteness can never be given the Linen by Soap and Ashes. The Influence of the Sun and Air, Acids, &c.

(*m*) Exper. & Obs. p. 6.

[*m*] As it does Silk,

are necessary on that Account. But surely the Lime at the Beginning, would much further the freeing it of all that Soap and Ashes can take out. The Experiment is easy and safe. But to proceed to the Compositions in which Quick-lime is used: The first I mentioned, is the

9. *Lapis septicus, seu Cauterium potentiale* Offic.; or, The common Caustic. This is a Lixive of Potash and Calx vive evaporated, melted, and while warm, cut, or formed into such Points, Dice, or other Figures, as are fittest for Use. Some make the Leys of one Part of Quick-lime, and two Parts of Potash; others take equal Parts of each: And no matter which Proportion be chosen, for the Strength of the Caustic is much the same in either Case. Here the common Soap-leys is generally used; which takes one Part of Quick-lime for two Parts of Potash.

Mr *Lemery* (*n*) observes, that sixteen Ounces of Potash, and eight Ounces of Calx vive, will yield only eight Ounces of Caustic, though ten or twelve Ounces of Salt may be got from the sixteen Ounces of Potash alone, the Calx retaining much of it. His Potash, it seems, has not been very good. That the Lime will retain a great deal of the Salt, is very certain, be it good or bad: The more therefore of the Quick-lime is taken, there will be proportionally the less of the Caustic obtained.

The *Edinburgh* Dispensatory, Edit. 1722. directed the Lixive to be made *Cineris clavellati & Calcis vivæ ana p. æ.* following the then new *London* Dispensatory, which made the *Cauterium potentiale, sive Lapis septicus*, the same Way; adding, *Simplicius fieri potest ex saponis nigri, & calcis vivæ partibus æqualibus commixtis.* Our two succeeding Editions keep the same Proportions, altering only somewhat the Process, with a View to render the Preparation still more corrosive; its chief Excellency consisting in its Strength, and in the Suddenness of its Operation. And I know no Improvement can be made of it, if it be not the diminishing the Quantity of

(*n*) Chym. p. 388.

the Quick-lime, for the Reason above mentioned; or for the Ease of the Operator, following the Directions 1722.

The new *London Dispensatory* has thrown out the two Caustics of the former one, called *Lapides infernales, sive septici*; and substituted in their Place a *Causticum commune fortius*, & *Causticum commune mitius*, (which last differs little from the *Cauterium simplicius* of the former Edition, taking only *Sapo mollis*, in place of *Sapo niger*), the strongest of them being much weaker than that made of Soap-leys. For it is thus ordered: *Lixivium saponarium supra dictum, coque ad partem quartam; deinde calcem vivam, quæ in pulverem trita, cribrata, & vase vitreo subere obturato asservata fuerit ad plures menses, huic lixivio, dum adhuc ebullit, insperge, donec omnem liquorem absorpserit, ut fiat pasta, quæ vase optime clauso servari debet (o)!* Thus translated by Dr Pemberton (p): “Boil to a fourth Part any Quantity of the Soap-leys above described; then sprinkle in, while boiling, Lime that has been kept in a vessel pretty close stopt for several Months; continue to add this Lime till all the Liquor is absorbed, and the whole reduced to a Paste, which is to be kept in a Vessel well stopt.” To which the Doctor subjoins this Remark: “The Design of thus keeping the Lime before it is used, is, that its Acrimony may be a little abated. This Caustic is preferable to that called the *Lapis infernalis*, as it will not liquify like that, by the Moisture of the Part on which it is applied; and by this means keeps better confined within the Limits in which it is intended to operate.” This therefore is not a literal Translation; yea a Line is omitted, there being no *English* for *in pulverem trita, cribrata, vitreo, subere*; and probably of Design. Whether Calx vive corked up in a Bottle, will keep several Months without falling down into a Powder, I have not tried: But whatever Way it is reduced to a Powder, sifting it is not unnecessary; though keeping it se-

(o) Ph. Lond. p. 43.

(p) p. 185.

veral Months *in vase vitrea subere obturato*, certainly is. For as thus keeping it can have little if any Effect that Way, so the less it has, it is so much the better; the freshest Quick-lime, in my humble Opinion, not being too acrid to make it deserve the Name of *Causiticum fortius*, which the Reason given for preferring it to the *Lapis infernalis* seems to confirm. For if it do not liquify by the Moisture of the Part to which it is applied, it will not be Caustic at all; if a small Part of it only and slowly liquifies, it will be but a more tedious Caustic, and consequently protract the Patient's Sufferings.

Mr *Lewis*, in his Translation of our Dispensatory (q), has complimented us with another Caustic, "which, he says, is not only more easily prepared, and at less Expence, but the Use of it is likewise free from several Inconveniencies, which unavoidably attend the other, and the common *Lapis infernalis* of the Shops." It is made of a strong Solution of a fixed alkaline Salt in boiling Water, thickened to a Paste with fresh flaked and sifted Lime; so must be weaker than the *London* one made of their Soap-leys. It is certainly a very cheap one; and will not spread much on the Part to which it is applied, neither liquifying nor corroding soon. I would prefer the *London* one to it; but their *Lapis infernalis* to them both; which, if I be not much mistaken, will do more in half an Hour, than they in two Hours. They are not like indeed to run in the Air *per deliquium*; so will keep without Glass Bottles close stopped. What I made of both Kinds, though mixed without Heat, turned soon hard, but in a few Days became very friable; which makes me think they might be kept in Powder.

10. *Sapo*, *Sapo albus*, *sive Hispanicus* Offic. *Sapo albus Hispanicus*, Ph. Edin. 19. *Sapo durus ab Hispania*, Ph. Lond. 18. *Spanish* or *Alicant* Soap, *vulgo Castile* Soap, is the corrosive Lixive of Potash and Quick-lime intimately united to, and sweetened by Oil Olive. The Consequences of this Union, as well as the Manner

(q) p. 262.

whereby it is accomplished, are too well known to be insisted on here; so I shall only observe two or three Things concerning it; as, that

(a) There are many Kinds of Soap, as hard and soft, white and black, &c. The Lixive is commonly much the same in all; but the Oils are not; and to this the Difference is chiefly owing. The common black Soap is made of Fish Oil; and sometimes used in Sinapisms, though a very disagreeable, and, in my Opinion, not a very useful Ingredient. But it is only Soap made of pure Oil Olive, or such like vegetable Oil, that is taken inwardly; and such the *Spanish* Soap is supposed to be. And Mr *Geoffroy* found (r), that two Ounces and two Drams of *Alicant* Soap digested for some Time in distilled Vinegar, gave of very limpid Oil of Olives, twelve Drams and fifty-four Grains; that is, more than two thirds of this Soap is pure Oil. And the same learned Chymist, in a Memoir which he sent to Dr *Hartley*, observes, that, “by pouring a vitriolic Acid into a Decoction of two Ounces of this Soap, he obtained one Ounce three Drams and twenty Grains of Oil of Olives: Which agrees with an Experiment made by Dr *Hartley* to the same Purpose (s). Hence we see, that even boiling Soap-leys cannot corrupt or destroy the Nature of Oils: Which confirms the Observation, § 2. N^o 3. And *quo alcali purius, quoque oleum magis sincerum, nec odore nec sapore ingratum, eo semper producetur sapo melior, inque usus inprimis medicatos pulchrior.*” Vid. Boerh. Chem. 2. p. 257. ad 260.

(b) The *Spanish* Soap is a mild, yet efficacious emollient, detergent, diuretic, and laxative Medicine; of great Use in the Gravel, Jaundice, and other Obstructions in the *Viscera*, &c.; and outwardly, in Pains, slight Inflammations, Tumours, and foul Ulcers. It may be given to an Ounce, or two, in some Circumstances.

The detergent Nature of Soap, of which none can

(r) Mem. Acad. 1741.

(s) Vid. Dr *Hales's* Exper. & Obs. p. 13.

be ignorant, intitles it to all these Virtues ; if it be not its Effects on Gravel-stones, of which however, by Dr *Hales* and Dr *Whytt*'s Experiments, it is found to be a very powerful Dissolvent. But that it may be taken in so large a Quantity, we much owe to Mrs *Stephens*'s strange Remedy, which perhaps is the chief Benefit the Public has had by it. I said it may be given, in some Circumstances only, to two Ounces, meaning the Stone: But for the most part one Ounce, yea half an Ounce, is enough every Day, even in that Disease; because it generally, in that Quantity, purges: And what goes off that Way, cannot act on the Stone. The best Rule therefore for regulating the Dose in the Gravel, is, to take so much of it as keeps the Belly soft, without purging more than the Patient used to do in Health.

For the Lixive, of which the Soap is made, Stone Quick-lime is commonly chosen as the strongest; next to it the Chalk Quick-lime. How Shell Quick-lime would answer, I know not.

S E C T. III.

The most common Preparations of Quick-lime, are Calx lota, and Lixivium, or Aqua calcis.

1. *Calx lota*, or washed Lime, is what remains of the Calx vive, after all that Water can dissolve is separated; or the indissolvable Part of it, by itself. It has been generally believed, that Quick-lime three or four Times washed, in a sufficient Quantity of Water, *plane mordacitatis expers constituitur, ac strenue absque mordacitate exsiccat* (t); which is very true, if a sufficient Quantity be used, and as many Days allowed to do it in. *Vid. § 1. N° 6. 7. 8.*

In *Zwelfer's Pharmacopœia Augustana*, Lime is thus ordered to be washed, for the *Unguentum e calce*: *Calcem vivam singulis diebus semel lavabis, & in fundo residere permittes, atque aquam spongia exprimes decem diebus continuis. Deinde aqua rosacea lavabis, & siccari fines. Vid.*

(t) *Vid. Galen. Simpl. l. 9.*

p. 344. Of this, with Oil of Roses and white Wax, the Ointment was made; which was long a famous Epulotic, and deservedly thought so. By the old *London* Dispensatory, the *Unguentum de calce* was made of Calx, at least seven Times washed, but no Time fixed for it. In 1721 it was thrown out. And a false Opinion prevailing, viz. that so many Washings rendered the *Calx instar terræ mortuæ*, by the succeeding Edition of that *Ausburgh* Dispensatory, in the 1684, the Number of Lotions is left undetermined. Yea in both these Editions there is also another Ointment, made of Lime once washed, and common Oil only, and commended for Burnings; which, from the Effect of the Oil on the Lime, may probably be concluded to have retained no hurtful Acrimony. The Lime fully washed, is still absorbent and antacid; and the *Cremor calcis*, or Crusts of Lime-water, seem not to be inferior to any of the testaceous Powders; but these are no better than Chalk externally applied: And this being the Way the *Calx lota* was used, its Efficacy depended alone on the small Degree of Acrimony it retained. *Calx lota exsiccat sine mordacitate, adeoque valet ad contumacia ulcera, v. gr. venerea, uti & ad ambusta, & alia, quæ non facile curationem admittunt.* Schroder. 353. There is nothing in either malignant, repellent, or adstringent, which can be said but of a few of the *exsiccantia* or *cicatrisantia*. But it is at present in desuetude, I believe every where.

2. *Aqua calcis*, *Aqua benedicta*, *Lixivium calcis*, or Lime-water, is Water impregnated with as much of Calx vive as it can dissolve, as has been sufficiently explained above.

The *Lixivium calcis*, or *Kovia* of the *Greeks*, according to *Galen*, l. c. was the first Water in which Quick-lime was washed; and in the Opinion of some, what *Hippocrates* (u) designs by *τιτανος ἐν ὕδατι ὡς μὴ ἐλκωσῆς*, ordered for the *Alphus* and *Lepra*. But whatever is in this, the oldest Author that I have met with, who particularly describes the modern Way of making Lime-water, is

(u) Pop. 2. § 5.

Anselmus Boetius de Boot, in his *Gemmarum & Lapidum historia*, p. 523. thus: *℞ Calcis vivæ unc. iii. Aquæ pluviæ lb. i. ss. M. & stent triduo in vase, postea agita, agitata quiescat per 24 horas in vase obturato, deinde coletur per linteum.* For, according to *Renodæi Antidotarium* (x), *Aqua Calcis est aqua in qua pluries calx exstincta fuerit.* The *Phar. Bateana* keeps *De Boot's* Proportions; but the Water is ordered to be boiling hot, and filtered so soon as it has subsided. The *Edinburgh Dispensatory* agrees with *Dr Bates*, omitting only Filtration; and adding, *Post agitationem validam subsidat calx*; a Circumstance not to be omitted. In the *London Dispensatory*, Edit. 1721, the Receipt is, *℞ Calcis vivæ lb. i. affunde aquæ bullientis lb. xii. post ebullitionem subsidat calx, & coletur liquor.* In the last Edition, *℞ Calcis vivæ lb. i. Aquæ lb. xii. affunde gradatim aquam; post ebullitionem subsidat calx, & liquor per chartam coletur.* The *Paris Dispensatory* makes a first and second, thus: *℞ Calcis vivæ lb. i. sensim affunde aquæ communis lb. x. post ebullitionem completam, & debitam residentiam, cola ad usum. Aqua calcis secunda. ℞ magma aquæ calcis primæ, affunde aquæ communis lb. vi. post viginti quatuor horas filtra, & serva.* *Cod. Medicam.* p. 205.

But by many Experiments I have found, that it is altogether indifferent whether the Water be hot or cold, poured on gradually or at once, the Water poured on the Calx, or the Calx thrown into the Water; whether the Calx vive be in Shells or flaked, or even exposed to the Air for several Months, for such Quantities of the Water as are commonly used; and if the Quick-lime be fresh, whether for one Pound of it, eight, ten, twenty, fifty, or five hundred Pounds of Water be taken. Only it is necessary, even for the first Water, after the Ebullition is over, to stir and mix the Lime with the Water, and allow it Time to impregnate itself; which is best known by the Crust formed on its Surface. Filtration indeed is not necessary, if it be not to prevent any undissolved Lime being mixed with it,

(x) p. 319.

or Crusts diminishing its beautiful Transparency. Some of the Experiments I mentioned, are related above. I shall here add an Account of the Way I used it, which may confirm several Things formerly advanced.

3. Having poured about eight Pounds of boiling Water, upon a Pound of Stone Quick-lime in a glased earthen Vessel, I began to drink it the 6th of *July* 1748, taking at least a Pound, or four Gills of it, every Day at Dinner, besides a Gill Morning and Evening frequently. I continued thus to use it for sixteen Months; filling always up the Vessel, as it needed, with fresh Water, sometimes hot and sometimes cold, without observing any Difference in the Lime-water, which I constantly filtered through gray Paper before I drank it. In *November* 1749, I made some Shell Lime-water, and drank sometimes this and sometimes the other for eight Months more. Yet in the Beginning of *September* 1750, the Lime was not exhausted, nor the Water sensibly weaker, when it stood a sufficient Time on the Lime; which I knew, as noticed above, by the Crusts. But the Lime becoming considerably lighter, after it is long thus used, for some Months it required several Days to subside, and form the Crusts: And at length, even after the Crusts were formed, did not leave one half of the Water clear, that it did at the Beginning; so I threw it out, after it had afforded me, I may say, six hundred Pounds of Lime-water. I shall only add, that although I was delivered from the Cause of all my Complaints (*viz.* of a Stone an Inch and a Quarter long, and as much round where thickest, which had lodged in the Bladder for more than a Year) 27th *May* 1750, having taken of Soap Pills about half an Ounce, for two or three Days only; yet Lime-water agrees so well with me, that I continue the Use of it to this Day; taking indifferently that made of Lime-stone, or of Chalk, or of Shells, and sometimes the Lime-water made of all the three together, without being able to discover any Difference in their Effects. But so much Lime-water is not to be obtained from Quick-lime, unless it be fresh, compleatly calcined, and free of heterogeneous

terogeneous Substances; for if defective in any of these, it will yield proportionally less Lime-water.

S E C T. IV.

Lime-water is diluent, detergent, antiseptic, anthelmintic, diuretic, and vulnerary; useful in all Diseases proceeding from, or accompanied with Obstructions in the Bowels or Glands, viscid Phlegm, calculous Concretions, or Putrefaction; and commended for the Scurvy, Scrophulæ, Gravel, Consumption, Empyema, Asthma, Arthritis vaga, Oedematous Swellings, Diabetes, Fluor albus, Fluxes, &c.; and outwardly for Diseases of the Skin, Ulcers, Gangrenes, &c. It may be taken to a Pound, once, twice, or thrice a-day, or used for common Drink.

This Water, which was long looked on as a Caustic (y), has been found of late, and I believe in the last Century only, to be a very safe and valuable Remedy; and *multum facere in plurimis casibus epota* (z). Who first ventured to give it inwardly, I know not; but Willis, Bates, Morton, seem to have used it much. The great Boerhaave also commends it not a little; but at the same time cautions against giving it in putrid or putrescent Distempers. *In illo autem scorbuto* (says he (a)) *qui a putrefacto pendet, inque oleo & sale acri consistit, nocet quam maxime.* And below: *In alcaliscentibus, biliosis, salinis putridis, resolutis cum acri, calidis, acutis, nimis jam motis, obest.* And it must be owned, that this appears, at first Sight, to be a natural Inference from the Effects of Quick-lime on Sal Ammoniac, Urine, &c. Nevertheless I have attributed to Lime-water an antiseptic Virtue, for several Reasons; which, with some

(y) *Lixivium velut lotura cineris est* (says Paulus, Prin. Med. l. 7. p. 627.); and below, *Si vero etiam calcem assumat cinis, ustoria vi præditum lixivium facit, quod etiam Πρωτοσακτον nominant; & medicamentis quæ per clysterem in sedem infunduntur maxime miscetur. Omnium autem fortissimum est quod ex sola calce fit.*

(z) Vid. Ph. Bateana, p. 6.

(a) Chem. 2. 316.

other Properties of this Liquor not hitherto well known, shall be particularly related. I observe therefore,

1. That the Taste of Lime-water does not always appear the same, even to the same Person; making sometimes a more and sometimes a less pungent Impression, according, to wit, to the Quality of the Saliva at the Time: But generally, to such as are unaccustomed to it, it at first tastes somewhat acrid and urinous; then notably salt or muriatic, especially if squirted to and again two three Times through the Teeth; and leaves an agreeable Sweetness in the Mouth behind it, which improves the Flavour of any Liquid taken after it. It gives no Smell of itself; but mixed with Ammoniacal Salts, it raises the volatile Spirit, and so must smell like it.

2. Lime prevents the corrupting of Water; and how long Lime-water may be kept sweet, or without spoiling, or becoming putrid, I have not found. For the Water in the Bell-glass, § i. N^o 7. never stunk like putrid Water, though Numbers of Hoglice have been killed in it; and any simple Water, in two or three Days, in the same Green-house, becomes pretty foetid. But I have kept Lime-water in a Bottle more than a Year quite sweet; as also Water, after it had thrown up all the Lime, and was filtered.

3. Lime-water kills Worms, and many other, if not all, Insects; and that commonly in less than half an Hour. For I made the Experiment on Earth-worms, black Snails, Shell Snails, which last threw out immediately a great deal of Slime, that became as yellow as Saffron; Caterpillars, *Scolopendræ valde exiles longæ*, R. H. Insect. 45.; long slender Worms taken out of a Cod's Stomach, Leeches, Ants, Hoglice; which last lived an Hour in it. Hence I concluded it might prove a good Anthelminthic for Children. And for a Girl eleven Years old, who for several Days complained much of Pains in her Stomach, and had some other Symptoms of Worms, I ordered a Gill of this Water to be taken, Morning and Evening, for three Days; and then an Infusion of Sena and Rhubarb. The Directions were followed;

followed; no Worms were observed to come away; but she was freed of all her Complaints, and has been perfectly well ever since, and better coloured. And having communicated this to Dr *Rutherford*, who was then giving *Clinical Colleges* in the Royal Infirmary, he prescribed it for an old Woman, who had been for a long Time excessively troubled with these Vermin, and effectually cured her, by Lime-water alone. And several others since have experienced its good Effect that Way.

Hence it is very probable, that Lime-water may be of great Use in long Sea-voyages, in preventing the Corruption of their Water, or Insects breeding in it, as well as curing the Diseases to which Seafaring People are most subject. The Experiment is certainly safe, easy, and attended with no Expence; one Pound of fresh well-burnt Calx vive of any Kind, being enough for a Hoghead of Water (*b*). Which may not only be used for common Drink by the Diseased, or for Prevention by the Healthy; but also, by boiling, and exposing it to the Air for a short Time, it may be reduced to sweet Water, and used in dressing the Victuals of the most delicate. Moreover,

4. Lime-water makes no Ebullition with acid Spirits, vegetable or mineral, no Precipitation; though the Crusts it forms, are notably absorbent. Yet it turns yellow, and precipitates a Solution of corrosive Sublimate; but turns white or milky, Solutions of either volatile or fixed alkaline Salts, which Acids again clarify. When mixed with Syrup of Violets, it gives it a green Colour; but commonly this Colour fades in less than an Hour, and turns yellowish: Whereas the Water in

(*b*) But as there is no Danger in ten times that Quantity, yea nor in any Quantity, so be the Water be filtered; it is not amiss, to prevent the Water's throwing up all the dissolved Lime, in a long Sea-voyage, to take for the Hoghead of Water four or five Pounds of Quick-lime: though I found, that one Dram of Stone Quick-lime preserved an *English* Gallon of Water, in a wide-mouthed wooden Vessel, with only a Timber Cover, near five Months; when I threw it out quite sweet, and free of Putrefaction.

which Lime kept dry for about two Years was infused, and which communicated no other Quality to it that I could discover, when a little Syrup of Violets was dissolved in it, became of a much deeper Green, and did not fade in less than six Days; neither did it then become yellowish, but bluish, as if it had been diluted with common Water only. Powdered Chalk has much the same Effect on diluted Syrup of Violets. Hence the Virtues of Lime-water do not depend on its Absorbency; and it may be as justly called antacaline as antacid. This a learned Physician, and Friend of mine, confirmed from his own Experience; who being much troubled with a grating Acid in his Stomach, and using Lime-water on another Account, found it had no Effect on his *Cardialgia*.

5. Lime-water prevents, or long protracts the Putrefaction of Animal Substances. The 22d *January* 1751, having in one Phial Stone Lime-water, and in another Fountain-water, I put into each a little Bit of fresh Beef, and corked them up. I did not draw the Corks till the 1st of *February*; when the Fountain-water was become very foetid, but the Lime-water not in the least tainted. And thus it continued till the 1st of *May*, when I took both out. That in the Fountain-water was corrupted and abominably foetid; but the other quite sound, and not at all putrid, more than when put into the Lime-water. There were adhering to the Sides of this Lime-water Phial, numerous little crystalline Bodies formerly described. Which are very different from what *Leuwenhoek* calls a Salt, in his *Observationes de figuris salis*, p. 137.—143. Where he gives the Figures of some small Particles, of the Lime probably, which his Glasses discovered, both in Water wherein he put some *Calx lapidea quæ Leodio advehitur*; and also Water with which he mixed some *Calx ex conchis marinis*. But at the same time he notices, that they do not, like other Salts, dissolve in Water. *Nam quemadmodum* (says he) *diversæ particulæ salis, quæ ex cineribus conficiuntur, pleræque omnes minimo humore dissolvuntur, aut in aquosam commutantur substantiam; sic hæ particulæ salis, ex calce provenientes,*

provenientes, e contrario in summo humore obdurantur sive rigescunt, adeo ut easdem rursus in aquosum converti humorem nunquam viderim.

September the 7th I began the same Experiment on Fish, putting into each of the Phials a Dram Weight of a fresh Haddock; there being in the one five Ounces of Shell Lime-water, and as much Fountain-water in the other. The Fountain-water stunk in two Days Time; but the Lime-water smelled only of fresh Fish, and continued so to do till January 1752, when it was taken out as sweet as ever; while that in the common Water was putrid enough, as may easily be imagined.

I mixed one Part of filtered ten Months old Herring-brine, which was of a deep reddish brown Colour, and very transparent, with two Parts of Lime-water. The Mixture became immediately white and turbid, without any observable Change of Smell. But on adding two Parts more of Lime-water, it smelled of the Spirit of Sal Ammoniac. The Mixture precipitated a white mucous Substance, and became as clear as Water above: And the volatile *Alkali* being driven off, it smelled only of well and recently cured Herrings. Old salted Beef-brine treated the same Way, gave the very same *phænomena, mutatis mutandis*.

Lime-water has not quite the same Effect upon Urine, as on Brine, if we are to judge of its Putrefaction by its pungent Smell. For mixed with the Urine new made, of a Person in perfect Health, it precipitates plentifully a white mucous Substance; yet does not increase nor alter its Scent for five or six Days; nor raise from it, in the common Air, any thing like the Spirit of Urine. But soon after, the Scent becomes pretty strong, and so continues; but still less so than if no Lime-water had been mixed with it. I mixed Lime-water with the Serum of very fizy Blood, being taken from a Person in a Fever; also with Ox-gall, both new and old; with much the same Appearances. It is not amiss however to notice, that the Gall, which had been kept in an open Bottle from May 20. to August 3. smelled as sweet as Musk, though it was formerly fetid;

tid; and being mixed with Lime-water in a Drinking-glass, and set in a Window, it retained its sweet Smell till all the Humidity evaporated. The fresh Gall had no Smell, stunk in a few Days, and in two or three Months got the musky Scent by itself. But Lime-water neither destroyed the Perfume, nor increased the *fætor*; though it gave both a whey Colour, and precipitated some *mucus*. (But since I found, that one Part of the Serum of the Blood, mixed with three Parts of Lime-water, stood more than seven Weeks before it became the least foetid; as also Urine treated the same Way) (c). Hence I think it follows, that Lime-water is notably antiseptic; and also that,

6. It corrects the marine Salts, not by converting them into a Sort of Sal Ammoniac, or any way volatilising them; but by disengaging or extricating these muriatic Salts, in our Juices, from such adhering alkaliescent or putrescent Substances, as clog and hinder their acting agreeably to their own Nature. For as it is certain that Sea-salt never can, either by Lime-water or Quick-lime, be turned into Sal Ammoniac; and, on the contrary, that they, by dissipating the volatile Spirit of that Salt, rather regenerate a Sea-salt: so al-

(c) Many Experiments made by others, as well as by myself, have confirmed the antiseptic Virtue of Lime-water. Not only Haddocks, Herrings, and such small Fishes, have been preserved from Corruption in it for several Weeks; but even Quarters of Veal, beginning to spoil, have been recovered by it, and kept sweet for several Days after, though in the Heat of Summer. I infused in it, on the 29th of May, a Salmon of ten Pound Weight. The 6th Day of June thereafter, there were no Signs of Putrefaction: but on the 11th, when taken out, it was much spoiled, and not eatable. In general, it is to be observed, 1. That the Quantity of the Lime-water must be proportioned to the Quantity of the Substance to be preserved. I took commonly for one Part of Flesh or Fish, about forty Parts of Water. Less will suffice, if a small Quantity of Quick-lime be added. 2. That if the Substance be very putrescent, it is proper, after infusing 24 Hours, to renew the Water, and add some Quick-lime, e. g. an Ounce for every *English* Gallon of Water. And, 3. That if it be large, or to be long kept, it should be also cut into inch-thick Pieces, but as broad as is convenient.

so that the Sea-salt has been unjustly blamed as the Cause of several Diseases of the Skin, of the Scurvy, of the Gravel, &c. its natural Effects sufficiently evince; and it has been found by Experience, to be rather a Remedy in such Cases. And this seems to be one Way the Lime-water exerts its antiseptic Virtue, which the foregoing Experiments prove. And besides,

If Lime-water were putrescent, I do not see how it could do any good in almost any of the Diseases wherein it is most commended, and found to be most successful. Yea, I have often thought, that Quick-lime in the Ship's Well, would effectually prevent the corrupting of the Water, and consequently the putrid Steams, or foul Air thence arising, which proves sometimes fatal to the poor Men. (For I found it sweetened, even in Summer, the most foetid Water of our *North-Lough*).

7. The Virtues of Lime-water outwardly applied in many Diseases of the Skin, in Excoriations, Ulcers, Gangrenes, &c. are well known. It has been called *Chirurgiæ altera manus*. And perhaps there is not a better Gargarism, for several Sorts of sore Mouths and Throats, than Lime-water; which I have known also of great Use in the Toothach. Inwardly taken,

8. Lime-water has all the Virtues of the pure Element; which are not a few; and on which probably depend the good Effects of the mineral Waters, more than on the Minerals they contain. Hence at least it is diluent. *Monf. Lemery (d)* says, it commonly causes great Thirst, although, according to him, the Dose be from one to four Ounces only. But this is contradicted by Experience. It never had any such Effect on me; on the contrary, I found it quenched Thirst as well as simple Water, and Custom has rendered it as agreeable. It is also notably detergent and attenuating, yea more detergent than Soap itself, of mucous, viscid, and other animal *Sordes*; which makes it preferable, in many Cases, to the purest, as well as to mineral Waters. In a Word, such are its Effects, that I think

(d) Chym. p. 386.

Lime-water may be said, in general, to purify the Blood by Urine, with as good Reason, as any one Medicine whatsoever, especially from any putrid, purulent, or scorbutic Foulness.

9. That Lime-water is lithontriptic, has been demonstrated sufficiently by Dr *Hales*, and more fully by Dr *Whytt*. But these Experiments having been made with Lime-water of the first Infusion, assisted by an artificial Heat, I thought it might be of some Use to try the Effect of Lime-water, after fifty or more Infusions, on Gravel-stones, and in the common Air. Wherefore,

In *July*, as I remember, 1750, I put a little Gravel-stone, about the Size of a Lentil, into a Glass of this old Lime-water, and set it in a North Window; and not expecting any sudden Alteration, took no more Notice of it for several Days. But in a Week or so, it appearing at a Distance remarkably bigger than it was at first, I took it down; and viewing it through a magnifying Glass, observed a very remarkable Change of it: for it resembled nothing so much as the round Head of a little Shrub loaden with Snow, which, upon stirring it, fell down into a most subtile white Powder; a small Part of the Honey-combed Stone remaining undissolved. This seeming somewhat to explain how the Lime-water acts on the Stone, I repeated the Experiment several times on other small Stones, to discover more particularly the Process of this Solution. And, in short,

I observed, that sometimes in one, sometimes in two or more Days Time, there appeared on the Stones little round white Grains, as it were, not so big as small Pins Heads, but by the magnifying Glass little Balls, as of a very fine *Farina*; which gradually increasing, both in Size and Number, in a few Days covered all the Surface to a considerable, but an unequal Thickness, and gave the Appearance of the Shrub full of Snow I just now mentioned. Hence the terrestrial or solid Parts of the Stone, are not, properly speaking, dissolved, but only separated. Now, the Stone consisting of Earth, Oil, Salt, some Water or Phlegm, and much unelastic

unelastic Air, whatever can dissipate or separate from it any of these, will probably alter its Texture, or destroy the Cohesion of its Parts, or at least diminish the Force by which they cohere. Lime-water, therefore, by volatilising the animal Salt, and (if not destroying) preventing the Coagulation of volatile Alcalies; or by dissolving the Oil, or the Phlegm; or by its penetrating Detergency, separating the solid Parts only, may prove lithontriptic.

The Action of this Liquor on animal Salts and volatile Alcalies, seems sufficiently to evince its prophylactic Virtue, in preventing the Generation of the *Calculus*. But that it thus has Effect on the Stone itself, is not so evident: For if this was the Case, the Stone reduced to Powder by it, would probably be sensibly lighter than it was before; which it seems not to be, by the following Experiments.

October 19. 1751, I took two Fragments of a *Calculus*: The one weighed exactly twenty-five Grains; the other being lighter, I added a small Bit of the same Stone that made it twenty-five Grains also. This I infused in a Gill of Shell Lime-water, and the former in as much Chalk Lime-water, in separate Phials, close corked. The 12th May 1752, I filtered both, dried well the *Residuum*s; each of which weighed just twenty-five Grains, as at first. I then separated from what continued solid, all that was in fine Powder, or very friable; and the solid Part remaining of the Fragments in the Shell Lime-water, weighed fifteen Grains; of the other, seventeen Grains. Whether the Difference was owing to the greater dissolving Power of the Shell Lime-water, or to there being in it two Fragments, and but one in the other, and consequently less Surface exposed to the *Menstruum*, this Experiment does not determine. I therefore reduced the Fragment of seventeen Grains to fifteen Grains, put them into their respective Phials, in which were fresh Lime-waters of the same Kinds as above; and after three Months I filtered, and dried, and weighed what remained, or did not pass the Filter, and had of each fifteen Grains, as before. But the corroded

roded very friable Parts being separated, the Fragment of the Shell Lime-water weighed twelve Grains and a half, and the other twelve Grains only. I reduced the remaining Fragments to ten Grains each, and again infused them in their respective Lime-waters; the Shell Lime-water having had, the preceding Day, three Oyster-shells newly calcined put into it: And after twenty-eight Days I filtered, and weighed them when dry, and had of each ten Grains; from which having brushed off what was very friable, each weighed nine Grains: And both together being calcined in a Crucible for two Hours, were reduced to five Grains of a chymical Earth. Hence no Lime adhered to the *Calculi* (e). And therefore the Energy of the Lime-water probably consists in its penetrating Detergency, whereby insinuating itself among the solid Parts of the *Calculi*, or into their Pores, it separates them, or diminishes their Cohesion, but does not dissolve them; much the same Way as acid Spirits act upon Antimony in a higher Degree.

But there being some *Calculi* much more solid than others, yea some Coats of the same *Calculus* more firm and impenetrable than others, the Action of Lime-water on them, is neither so sudden nor so observable. I have kept some Fragments in it for several Weeks, with little Effect: On others it acted more on the inner Coats than on the outer one; and some it whitened only a little, and made the Surface somewhat more friable. However, generally, it raised on them some small round whitish Excrescences; which sometimes resembled in Form and Consistence little Mushrooms, especially the first Time that they were infused (f). And, so far as I have observed, it acted more easily on the *Calculi* of old People than of young; on such as were of a Clay or Brick Colour, than on such as were more white, or of a darker brown Colour.

10. Since there is but a very small Proportion of

(e) Vid. Hales's Stat. 2. 191.

(f) Very white when in Shell Lime-water; but often yellowish in Stone Lime-water.

Lime in the Water, it may be thought, that taking a few Grains of the Quick-lime in Substance, would prove much more effectual in the Stone, than large Quantities of the Lime-water. But this is evidently a Mistake. For supposing any Quantity you please, could be safely lodged in the Stomach or Guts, only what Water dissolves can enter the Lacteals; and though Plenty of Water were taken above it, it could dissolve no more there than Water can take up, or than there is dissolved in Lime-water; yea not so much, unless we could detain the Water so long on the Lime, as is necessary sufficiently to impregnate it; and how that can be done, I know not.

Hence Mrs *Stephens* her Egg-shells and Snail-shells, (the Snails being absolutely useless), if burnt to Quick-lime, how much Pain soever they may cause, can never be equally successful with Lime-water in the Stone. And if they be calcined only to a gray Colour, they yield little or nothing to Water, even when long infused in it. I attempted to calcine about a Dozen of Egg-shells in an open Crucible, keeping it red-hot for five or six Hours; and a very few small Bits, near the Sides and Bottom, only being white, I repeated the Calcination; yet, after all, not the fourth Part was become white. I poured Water on them; but neither Heat nor Ebullition ensued, nor did they fall into Lime. In two Days however a Crust formed on the Surface, and the Water was impregnated, but had a foreign disagreeably burnt Taste. So it will require a very strong Fire to calcine such a Quantity as she directs, to Whiteness, in a covered Crucible, in eight Hours Time. And of all the calcarious Substances that I know, Egg-shells seem to promise least, any thing of a lithontriptic Virtue, as she orders them.

II. As for the *aquæ benedictæ compositæ*, they are not to be compared with the simple Lime-water in the Gravel, nor, in my Opinion, in any Disease requiring it. For, so far as I can yet find, there is nothing that can with Safety be mixed or taken with it, that any way increases its lithontriptic Virtue, Soap or Soap-leys
F only

only excepted ; though many Things diminish it, yet quite enervate it as a Medicine ; of which Number I reckon Liquorish, Guajac, Sassafras, which, by their Oil, Mucilage, or Acidity, so sheath, or blunt its most penetrating Parts, on the Subtlety of which its Virtues depend, as to render them quite unactive. I could not therefore but be surpris'd, when I read in a late History of the *Materia Medica*, that “ simple Lime-water is principally intended for washing old Ulcers, and other external Purposes. When it is to be taken internally, the following Additions are made to it, (he means, the compound Waters are used), to take off its ill Flavour, or to add to its Virtues.” For even with regard to its ill Flavour, as he calls it, I know nothing but Custom can take it off, or improve it without diminishing its Virtue, as doth every acid and fermented Liquor. Pyrmont-water makes it more palatable, but weakens it : And to me Sugar makes it worse, Tea nauseous, and Sassafras abominable.

Thus I have finished what I designed on Calx vive. But some curious Experiments and Observations, being lately published by two very learned and experienced Physicians, and my particular Friends, which do not in every thing agree with what is above advanced ; I cannot conclude without endeavouring to discover where the Mistakes lie, and to correct them if I have fallen into any. To criticise on the Writings of others, is no less an invidious Task, than to me a disagreeable one ; and far from being the Design of the following Lines, which is only to shew, that I have advanced nothing without such Reasons as appeared to me convincing. And I persuade myself, that nothing can be more acceptable to us all, than to be delivered from Errors, and confirmed in useful Truths. *Licet amicus Plato, amicus Socrates, magis tamen amica veritas.*

I. Dr *John Pringle*, who was Physician-General to the Forces in *Flanders*, &c. during the late War, has published Observations on the Diseases of the Army ; with an Appendix, containing a great Variety of Experiments

periments relative to Putrefaction. And here, *p.* 395. he says, "To this Examination of Chalk and the *Tellurea*, were added some Experiments upon Lime-water, made both of common Lime and Oyster-shells: And I found, that Flesh infused in either, immediately sent forth a disagreeable Smell, as in a common Ley (a); yet it did not become putrid till after the Standard: So that, in this Trial, Lime-water made some small Resistance to Putrefaction, though the Materials, Chalk and Shells, are both Septics. Nevertheless, I have observed, that when the Putrefaction began, it became always much more offensive in this, than in common Water (b). And it will afterwards appear probable, that the Virtues of this Medicine do not consist in correcting Putrefaction; but, on the contrary, in checking immoderate Acidities, the Cause of many chronical Disorders (c)." And I have the Misfortune to differ from him in every Article. For,

(a) The 2d of *May* 1752, the Spirit being twelve Degrees above temperate, as marked in Mr *Fouler's* Thermometer, I took three Drinking-glasses, filling one of them with Lime-water, another with a Solution of Potash, and the third with a pretty strong Soap-ley; and put into each a Bit of a Lamb's Lights raw, and of a boiled Liver; in order to observe whether any of them "sent forth a disagreeable Smell." But none of them gave any such Smell, either immediately or after twenty-four Hours Maceration, more than the Leys themselves did, before these two pretty putrescent animal Substances were infused in them. Neither did I ever observe, that either Flesh or Fish, or any animal Substance, not of itself putrid, or ammoniacal, gave any other Smell than what they did before, on being infused in Lime-water. One Thing occurred on making this Experiment, which deserves to be noticed; and that is, the Liver sunk immediately to the Bottom in the Soap-leys, but not for several Hours in the Solution of Potash; not certainly by reason of its specific Gravity, for the Soap-leys was not lighter; but because *calce viva redditur adeo penetrabilis*, as the great *Boerhaave*

haave speaks. Hence also, both Liver and Lights were almost quite consumed in it in one Day's Time, and without Heat, though only contracted and hardened in the Solution of the Potash, and a very little blanched in the Lime-water.

In what Degree of Heat the Doctor made his Experiments, he does not mention here. If the Heat of the Lamp-furnace made Flesh immediately smell disagreeably, I cannot help thinking it was putrid before it was put into the Lime-water; or that that Method is not the best Way of determining the antiseptic or septic Powers of different Bodies. And I the rather incline to think so, because I find numbered among his Antiseptics, some Substances which are of themselves putrescent in a high Degree; I mean Cabbage and other Coleworts. How soon these putrify of themselves, and how noisomely foetid the Water in which they are boiled becomes almost immediately, is commonly known. Yea, if any Colewort be eaten raw, the *Ructus* it occasions, the Taint it gives the *Saliva*, the Urine, &c. in my humble Opinion, sufficiently prove it naturally putrescent. And I always took Garlick, Onions, Turneps, Horse-radish, to be of the same Kind; but neither Carrots nor Celery (g).

(b) Although by renewing the Lime-water on it, I believe Flesh might be preserved from Corruption, I do not know how long; and the same Lime-water I found prevented Corruption more than three Months; yet it is not to be expected, that it would never become foetid. But that "when the Putrefaction began, it became much more offensive in this than in common Water," is what I never observed, but rather the contrary, in every Experiment I made; and particularly in the following one.

April 20. 1752, I poured into one Phial a Gill of Chalk Lime-water, and into another as much of an Infusion of Camomile Flowers in Water, made as strong as possible with the same Flowers; and put into each a

(g) *Vid.* App. p. 389.

Dram Weight of fresh Salmon. The Infusion was very fine and transparent, and of the Colour of a Tincture of Aloes. *April 24.* it was become turbid, somewhat foetid, and had some mouldy Spots on its Surface. *April 28.* more turbid, still foetid, mouldy Spots gone. *May 1.* it smelled less foetidly, and more of Camomile; the Smell of the Flowers much lessening, and sometimes as it were overcoming the *fætor*. After five or six Weeks, the Scent became more disagreeable; the Infusion precipitated a good deal of slimy Stuff, but continued turbid. After they had stood macerating for sixty-eight Days, I took both out. That which was in the Infusion, was of a dark brown Colour, very tender and foetid; neither Colour, Smell, Taste, nor Consistence of Salmon remaining: Whereas the Piece that was in the Lime-water, was quite sound, retaining its proper Taste, Smell, Consistence, and Colour; being still reddish, and only a little blanched, but not in the least foetid. When I had kept both Liquors about six Weeks longer, and the Lime-water began to stink, I filtered both; and observed, that the Putrefaction of the Infusion was much more offensive than that of the Lime-water. And having mixed one Part of this foetid Lime-water with two Parts of fresh Lime-water, I observed also, though the Mixture was in a close-corked Phial, that in a Day's Time it lost its *fætor*, retaining only a fishy Smell, which some compared to that of Crabs, others to that of Lobsters. If therefore Lime-water is more antiseptic than a strong Infusion of Camomile Flowers, I leave it to my Friend to judge, whether it makes only "some small Resistance to Putrefaction."

I never thought the Virtues of Lime-water consisted only in correcting Putrefaction; but I was very glad to find that it had that Quality; and consequently was perfectly safe in such Cases, wherein otherwise it might have been hurtful, and was generally reckoned so. And it gave me great Pleasure to observe, that a small Quantity of Quick-lime could prevent the Corruption of a great deal of common Water; and consequently be signally useful

useful to Mariners in long Voyages, by contributing several Ways to the Health of that valuable Part of Mankind, on which the Prosperity of the Nation not a little depends, and for whose sake chiefly I have published this Paper.

Neither do I attribute the good Effect of Lime-water in Dysenteries, putrid Scurvies, internal Ulcers, &c. so much to its antiseptic Virtue, as to its penetrating, detergent, and diuretic Qualities; whereby it assists Nature to concoct and throw off what these Diseases had rendered morbid, or, if you please, corrupted. For I believe it hard to prove, that the Distempers most commonly called putrid, proceed from a previous Corruption either of the Fluids or Solids, and not the Corruption from the Diseases: It having been always my Opinion, that Putrefaction is more commonly (if not always) the Effect of the Diseases, than their Cause: Which might be illustrated by the History of the Small Pox, pestilential Fevers, Poisons, venomous Bites, yea of every infectious as well as putrid Distemper, were this a proper Place for it (*b*). But I cannot help observing, that my learned Friend seems to take Putrefaction in too large a Sense, when he says, "We know, that neither animal nor vegetable Substances can become Aliment, without undergoing some Degree of Putrefaction. Many Distempers proceed from a Deficiency of this Action. The Crisis of Fevers seems to depend upon it, and even animal Heat." *App. p. 386.* For I believe it will be found, that many animal as well as vegetable Substances, yield Aliment or nourishing Juices, without any Degree of Putrefaction; that the

(*b*) Among the Effects of Fevers in general, the very learned and accurate *Van Swieten*, mentioning the Putrefaction of the *Bilis*, *Saliva*, *Urina*, *Fæces alvine*, and of the Blood itself, adds, *Dum autem tales depravationes humorum, in cadaveribus febre mortuorum deprehenduntur, male incusantur, ac si causa febris fuissent, cum revera sint tantum febris effectus. Sic critica evacuationes inprimis hunc usum habent, ut illa quæ per febrim in morbosam indolem degeneraverant, expellantur de corpore.* Comment. in Aphor. vol. 2. p. 51.

Chyle of healthy People is not putrid; that some Animals may be nourished by Substances more putrid than their own Juices, and so in turning them to Aliment, must correct their Putrefaction; and that others which live on Antiseptics, are notwithstanding putrescent themselves in some Degree, at least when dead. In a Word, since every antiseptic Vegetable has a Power of changing the common Juices of the Earth into its own Nature, without any Degree of Putrefaction, I do not see why Animals may not have the same Power. As for the Distempers which proceed from a Deficiency of Putrefaction, I own myself ignorant of them; and also how the Crisis of Fevers depends upon it, if whatever attenuates, dissolves, corrects Acrimony, or alters the morbid Qualities of what is preternatural in these Diseases, is not included in that Term, or acts by putrifying: And if so, Lime-water may be said to putrify the Stone, and *Aqua fortis* Silver. And if we can be nourished without Putrefaction, and Cadavers putrify much faster than living Bodies, how animal Heat depends on it, I cannot conceive.

(c) That the Virtues of Lime-water do not consist in checking immoderate Acidities, is sufficiently proven above, particularly § 4. N^o 4.; and also that it really corrects Putrefaction, *ib.* N^o 5. But below the Doctor allows it another Quality than any I have assigned it: For, p. 415. he says,

“Lime-water neither retards Fermentation like the lixivial Salts, nor hastens it, nor makes it so violent as do the *Testacea*; and being besides of an astringent Nature, it becomes an excellent Medicine for such as have weak Stomachs, with a predominating Acid; as many have experienced that were subject to the Gout, Gravel, or other Diseases that seemed depending on that Cause.”

I have made no Experiments with it on Fermentation; but from the Doctor's it appears neither to act like lixivial Salts, nor the *Testacea*, which much more strongly check Acidities. It is true, the calcarious Crusts it throws up, are evidently absorbent, and check Acidities as well as Chalk; and also that the Virtues of Lime-water

ter depend on this, only so long as it continues in its dissolved State. But as it throws up few or none, unless exposed to the Air, as they have none of the Qualities of Lime-water, nor can ever after be dissolved in it, unless recalcined, and Lime-water makes no Ebullition with Acids; so I can attribute to these Lime-crusts only, the Virtues of the *Testacea*, in whose Place they may be substituted safely.

Since Lime-water feels soft and soapy, and neither thickens the Fluids, nor contracts or hardens the Solids, or any animal Substance infused in it, as evidently appears by the Effects of Lime in dressing Skins, and by the Experiments formerly related; its Success in the Cure of Fluxes and Dysenteries, is no Proof of its being astringent, as *Galen* long ago evinced; who, in the *Latin* Edition I have, thus argues: *Quidam medicamenta nonnulla, ex eo quod diarrhæis aut dysenteriis medentur, adstringere ea colligunt, quanquam ne minimum habeant adstrictionis; imo prorsum contra rarefacientia nimirum sint & laxantia: cum alioqui quæ astringunt, corpora contrahant, condensent, constipent, atque constringant. Nam adeps caprinus omnibus, quæ aut gustu, aut facultate sunt adstringentia, adversissimus est; veluti etiam farina triticea, & amyllum, & innumera eorum, quæ vim habent, tum emplasticam, tum mitigatoriam, atque acrimonias hebetandi, eaque ratione iis qui acria mordaciaque per album excernunt, auxiliantur. Sane esto & oleum ex adstringentium numero, quoniam sæpius infusum profuit (i).* But granting that Lime-water had both these Qualities, as some solid Substances, *e. g.* Filings of Iron, have, which in dissolving checks Acidities, and being by them dissolved, becomes strongly astringent; yet it will not be easy to prove, that either Gout or Gravel depend on a predominating Acid; or that Filings of Iron, though an excellent Medicine for such as have weak Stomachs, with a predominating Acid, is of equal Value with Lime-water in these Diseases.

II. My good Friend and Colleague Dr *Whytt* pu-

(i) *Gal. Simpl. l. i. c. 34.*

blished, in the *Medical Essays*, in 1743, an Essay towards the Discovery of a safe Medicine for dissolving the Stone, which has done much Good in that melancholy Disease. It was considerably enlarged by the Author, and reprinted with the *Essays*, in 1747; and in *August* last came out by itself, with many more Additions, and with this Title, *An Essay on the Virtues of Lime-water in the Cure of the Stone*; whereby it becomes more generally useful.

Here the Doctor (*k*) observes, that “it is far from being true, that Quick-lime is soon deprived of its Virtues by repeated Affusions of Water, or that the third or fourth Water procured from it, is altogether insipid, as some have affirmed.” And below he adds, “That some Stone-lime, which had been reduced to a Powder, by being exposed to the open Air for four Months, still retained some of its Virtue, after having had, during the Course of sixty Days, two hundred and sixty times its Weight of Water poured upon it: And some Lime-water procured from calcined Oyster-shells, upon which, in forty-eight Days, he had poured two hundred and seventy times their Weight of Water, was, by Experiment, found to be possessed of a considerable Power of dissolving the Stone.”

When I communicated to not a few, what Quantity of Lime-water I had got from a Pound of Quick-lime, it was generally disbelieved, and looked on as impossible; nor could the Doctor fully credit it till he made the above Experiments. And no wonder; for had it been told me before, I would probably have suspended my Assent until I also had made the Trial. To convince Dr *Rutherford*, who is very deservedly at the Head of our Faculty in the University, I sent him a Bottle of the Lime-water, which the Pound of Stone Quick-lime, mentioned above, *p.* 30. N^o 3. afforded, after about five hundred Pounds of Water had been poured on it: He was not a little surprised at its Strength, as he told me afterwards; and said, there appeared to be some-

(*k*) *p.* 43.

thing very wonderful in it; for, by the Taste, he would have taken it for the first Water. So I claim the Discovery; though Dr *Whytt* has not done me the Honour to mention me for it, probably because his Experiments come not out the full Length of mine, though they fall not much short of them.

For if “fresh calcined Shells impregnate Water more strongly than such as have had several Affusions before; and if double Lime-water, (that is, Lime-water made with calcined Shells hot from the Fire, rendered remarkably stronger by pouring it a second time on fresh burnt Shells), standing on the Shells a few Days, loses some of its Virtue and Strength, while the weaker Lime-waters are constantly supplied with fresh Virtue from the Shells, sufficient to make up what they lose by the Contact of the Air (1);” and yet Stone Quick-lime, after having been four Months exposed to the open Air, and having had two hundred and sixty times its Weight of Water poured upon it, still retained some of its Virtue; may it not be thought probable, considering the Influence of the Air on Quick-lime, and how much of what is dissolvable must have been thrown up in Crusts, during four Months and sixty Days, that if the Stone Quick-lime had been taken hot from the Lime-kill, it would have retained some of its Virtue, after having had many more (perhaps five hundred and twenty) times its Weight of Water poured on it? And can any Reason be assigned, why the tenth or twentieth Water should be weaker than the first, while there still remains Virtue in the Lime, if it be not that Water can bear no more of it? or that the same Quantity of the Lime dissolved in the Water after several Affusions, is not of the same Strength with that which the first Water takes up? And if this be the Fact, how comes there to be any Difference in their specific Weights, when filtered?

As for specific Gravities in general, I owned above how sensible I am of the Difficulty of determining them

(1) *Vid. Est. p. 41. & 42.*

accurately; and referred to the very valuable Tables of Dr *Richard Davies*, in the *Phil. Trans.* N^o 488. p. 436. to 489. Where that learned Gentleman has with great Pains, and no less solid Judgment, collected all the Experiments of that Kind that have been made by the most accurate Authors, shewing how widely they disagree, pointed out the Causes of such Difference, &c. In a Word, he seems to have exhausted that Subject. I cannot however but observe from these Tables, that, according to the great Mr *Boyle*, a cubic Inch of Water weighs two hundred and fifty-six Troy Grains; but, according to the accurate Mr *Ward* of *Chester*, 253.18.; that is, Mr *Boyle's* Water is to Mr *Ward's*, as 64 to (63.295. or nearly) 63.3. And yet Mr *Boyle* (in his *Medicina Hydrostatica*) says, "Having examined the Weight of divers Waters, I found the Difference between their specific Gravities far less than almost any body would expect; being but about one thousandth part of the Weight of either, even between Waters where one would expect a notable Disparity. Nor did I find any Difference considerable between the Weight of Spring-water, River-water, Rain-water, and Snow-water, though this last was somewhat lighter than any of the rest." Even by my imperfect Way of weighing in the Flask, I have found the full of it cold from the Fountain, thirty Grains heavier than what had stood some time in my Chamber. I therefore hope the Doctor will not be offended, though I say, that

There appears to me to be some Mistake, in making any Lime-water, if filtered through gray Paper, to be to our Fountain-water as 169 to 168 (m). For thus a hundred and sixty-nine Grains of this Lime-water must not only contain a Grain of Lime, but also so lodged in the Water, as not to increase its Bulk; and consequently three Ounces, or a thousand four hundred and forty Grains of this Lime-water, must contain more than eight Grains and a half of Lime, though I could hardly account for the two Grains of calcarious

(m) *Vid. Est.* p. 40.

Crusts which that Quantity of any of my Lime-waters yielded (*n*). And Dr *Langrish's* Pint of strong Lime-water evaporated, should have left, not sixteen, but more than forty-one Grains of a calcarious Substance. But allowing the specific Gravity of his strongest Lime-water to have been to that of Water, as 286 to 285 (*o*); and supposing an *English* Pint of Spring-water to weigh exactly one Pound Apothecaries Weight, (though it weighs three Ounces, wanting thirty-one Grains, more than the Apothecaries Pound of twelve Troy Ounces), and that the same Quantity of Dr *Langrish's* strong Lime-water would have weighed one Pound, and twenty-seven and a half Grains, by Mistake for twenty-three and a half I suppose: is it at all probable, that Quick-lime, after long Calcination, will communicate to a Pint of Water eleven and a half (or seven and a half) Grains of such a subtile active Matter, as must by Distillation, as well as by Evaporation, fly off from or with the Water, and evanish, or escape through the Luting or Pores of the Vessels? This must be more subtile and volatile than a volatile alkaline Salt itself; which yet the Doctor owns (*p*) would have been expelled by the Fire. Neither does it appear to me very probable, that such subtile volatile Matter would increase the specific Gravity of the Water. The Analogy between some mineral Waters and Lime-water (*q*), seems to explain nothing here; their martial Spirit, as it is called, being an inflammable Sulphur; and if it increases the specific Gravity of the Waters impregnated with it, it is more than I know.

Besides, since Soap-leys (*r*) made by pouring two Pounds of boiling Water upon four Ounces of purified Potash, and five Ounces of calcined Oyster-shells fresh from the Fire, and let stand twenty-four Hours, was neither so corrosive nor disagreeable as the *Glasgow*

(*n*) *Vid.* p. 8. 9. 10. *supra*.

(*o*) *Vid.* *Ess.* p. 66.

(*p*) *Ess.* p. 65.

(*q*) *Ess.* p. 63.

(*r*) *Ess.* p. 84.

Soap-leys, and its specific Gravity less by a twenty-fourth Part ; while the dissolving Power of the lightest was above one third stronger ; the Shell Soap-ley dissolving a Thirteen-grain Piece of a *Calculus* entirely in ten Hours warm Digestion ; and the *Glasgow* Soap-ley taking sixteen Hours warm Infusion to do the same : Hence (supposing the Quantity of the *Glasgow* Soap-ley to have been the same with the other, and that the Doctor examined the Condition of the *Calculus* in it, after ten Hours warm Infusion, though not mentioned here) one would think, that the specific Weight of Shell Lime-water could not be much greater than that of Stone Lime-water, nor its superior lithontriptic Virtue be accounted for from its greater specific Gravity (*f*). But whatever is in this,

That a general Position is not always well founded on a single Experiment, might be proved by many Instances ; but I need go no further than the Essay (*t*) for a notable one. For there the Author informs us, that “ he found a Solution of *Alicant* Soap in Stone Lime-water had a greater dissolving Power, than either a Solution of Soap in common Water, or Lime-water by itself, or even than the Aggregate of the dissolving Powers of Soap and Lime-water when unmixed :” And then relates the Experiment on which this Position is founded, which is as clear and conclusive as one Experiment can be. But in the following Paragraph he candidly owns, that at “ another Time, when he made the same Experiment, he did not find the Virtue of the Lime-water so much increased by the Soap.” I may therefore be allowed to relate an Experiment or two which I made.

I put into one Glass two Ounces of a very clean and apparently pure Potash, (of which cold Water left only a sixteenth Part undissolved), and one Ounce of flaked Quick-lime ; and into another Glass also two Ounces of the same Potash, and an Ounce of calcined Oyster-

(*f*) *Vid. Est.* p. 42.

(*t*) p. 89. & 90.

shells, very white and brittle, and fresh from the Fire, but not hot; and poured on each two Gills of cold Water, in order to compare the Strength of these two Soap-leys; whereof let the first be A, and the last B. When they had stood twenty-four Hours, and been stirred and shaken several times, I poured off and weighed a Gill of each as accurately as I could; and found A just four Ounces Troy, but B eighteen Grains lighter. Then having poured them into two different wide-mouthed Phials, I put into A a Fragment of a *Calculus* weighing twenty-five Grains; and another Fragment of the same *Calculus* of twenty-one Grains only, into B; and set both in a North Window. In about twelve Hours Time A became a little muddy round the Fragment; and after twenty-four Hours only, several little Bits of it were fallen off; while the Fragment in B discovered no Signs of Solution for two Days. After they had stood four Days and sixteen Hours, I filtered A; and eight Hours after, B. And having with fresh Water washed away Part of the adhering Lixive, I dried both well, and weighed in the Papers, (which at first were exactly of the same Weight), and found the Paper A three Grains heavier than B: But carefully separating the Remainders of the Fragments from the Papers, that of A weighed nine Grains, and that of B twelve Grains; A being in Powder and small Bits, but B almost all in one Piece. This being a single Experiment,

I repeated it; taking for one Ounce of the above Potash, half an Ounce of Stone Quick-lime, which I had kept ten Days by me, and was crumbling into Pieces; and for another Ounce of the Potash, a full Ounce of Oister-shells, calcined for five Hours very white; and because they did not fall in Water, calcined a second Time as long; and treating all as above; the first being called A, and the other B, as before: I weighed a Gill of each, and found A to want only four Grains of four Ounces Troy, (being three Ounces seven Drams and fifty-six Grains); but B wanted one Dram and twelve Grains of the four Ounces Troy, (be-
ing

ing three Ounces six Drams and forty-four Grains); and so was sixty-eight Grains lighter than A. The four Grains which A wanted of the four Ounces, I attribute to the Potash's being softened a little by the Moisture of the Air; and B's being so much lighter than it was in the former Experiment, to the greater Proportion of the Shell Quick-lime taken in this than in it. See above, p. 23. These two Lixives being poured into the two Phials as before, I put into A seven Grains in two Fragments; and into B also seven Grains, but in four Fragments, of the same *Calculus* which I used in the former Experiment. These having stood forty-eight Hours, I filtered, and found the dried *Residuum* of A two Grains and a half; and of B only one Grain and a half. Whether this is owing to the greater Proportion of the Quick-lime in B than in A, or there being four Fragments in the one more than the other, I leave the Reader to determine, or future Experiments.

I also infused one Fragment of the same *Calculus*, weighing ten Grains and a half, in a Gill and a half of double Shell Lime-water; and ten Grains of the same *Calculus* in two pretty equal Fragments, in a like Quantity of single Stone Lime-water. After ten Days I filtered both; and being dried, the single Fragment weighed ten Grains, and the two Fragments only eight Grains.

I shall make no Inferences; but only observe, that I chused to make this as well as all my Experiments, without any artificial Heat, not only because I had not Conveniency for Furnaces, &c. but also because I thought it not easy, with sufficient Accuracy, to adjust and regulate the Fire, so as it might neither exceed nor fall below what it ought to be; either of which might mar the Experiment: And that therefore the comparative Power of *Menstruums*, in many Cases, was, with greatest Certainty, discovered in the common Air. And thus,

By all the Experiments I made, I could neither discover any Difference in the Strength of the Lime-water,

ter, nor in the Quantity of the Crusts it afforded, whether one Part of compleatly-calcined and recent Quick-lime had yielded ten, fifty, or five hundred Parts of Lime-water. But I know no body ever imagined (*u*), “that Water acquires the same precise Degree of Strength, whatever be the Quantity of Quick-lime upon which it is poured; as is observed of Wine in which *Crocus metallorum* is infused.” For neither can Quick-lime impregnate more than a certain Quantity of Water; nor *Crocus metallorum* more than a certain Quantity of Wine. But while that certain Quantity is not exceeded, I have not been able to discover, that either these Lime-waters, or antimonial Wines, differ in Strength; or any Reason why they should differ. For surely, if in any Case Analogy can furnish an Argument, it is here. Every *Menstruum* dissolves only as much of any thing put into it as it can dissolve, and no more by any means, in the same Degree of Heat. Water, for Instance, can take up only a certain Quantity of any Salt, or of whatever is dissolvable in it. Dr *Grew* long ago observed this; who, among other Things, notices, that two Drams of Senna will impregnate four Ounces of Water as strongly, as if four Drams were infused in it (*x*). The Lime-water (mentioned above, § 1. N^o 7.) still retains (at least some of) the Qualities of Lime-water; it kills Insects, gathers Crusts, is detergent, &c. as at first. Now, “if Lime-water were stronger or weaker in proportion as a greater or less Quantity of Quick-lime is added to the Water, &c. (*y*);” be this Proportion what it will, it must be very small. For it cannot be said, that the Strength of seven Pounds of Lime-water procured from two Pounds of Quick-lime, is twice as strong as it would have been, if only one Pound of Quick-lime had been used. But I say, be the Proportion what it will, if this hold, Lime-water may be made of any Strength

(*u*) Vid. Ess. p. 41.

(*x*) Vid. *Grew's* Experiments on the Solution of Salts in Water.

(*y*) Vid. Ess. p. 41.

you please, at least much stronger than was ever yet known. But to me it appears more probable, that Water can bear, or dissolve only a certain Quantity of Quick-lime; and if there be as much of Quick-lime in it as will afford this Quantity, and sufficient Time allowed, it will impregnate itself so fully as to be able to bear no more. And if there be such a Quantity of Lime in the Water, as will, after two or more Waters, still considerably impregnate fresh Water, I cannot conceive why the first Water should leave in the Lime so much of its dissolvable Part, and yet dissolve any Part of new Quick-lime infused in it.

I said this proportional Increase of Strength must be very small, and I may add, imperceptible. For if Lime-water procured from calcined Oister-shells, upon which, in forty-eight Days, had been poured two hundred and seventy times their Weight of Water, was nevertheless, by Experiment, found to be possessed of a considerable Power of dissolving the Stone (*z*); then these calcined Oister-shells would probably have impregnated as strongly five or six hundred times their Weight of Water, as they did the two hundred and seventy, if it had been all poured on at once, or in a short Time. And if the second Water was weaker than the first, the third than the second, and so on to the fiftieth or fifty-fourth Water, and yet this last considerably lithontriptic; their Decrease of Strength would not easily be perceived, nor determined, I think, without a greater Variety of Experiments than have yet been made, or perhaps can be made.

I noticed above (*a*), that flaked Lime makes an Ebullition in Spirit of Vinegar. This Ebullition, indeed, is not so violent as it is when the Crusts are infused in the Spirit, but nevertheless visible: And that some of the Lime is dissolved in it, appears by the *quasi* Vegetation which follows. As for the Experiments made in Vegetation with Quick-lime and Lime-water,

(*z*) *Vid.* Ess. p. 43.

(*a*) p. 17.

too long to be related, I have given briefly the Event of them in the *Tyrocinium Botanicum*.

That Quick-lime, after being rendered *almost* insipid by frequent Affusions of Water, acquires its former Properties by a new Calcination (*b*), is not to be doubted. But perhaps the almost insipid Quick-lime was not divested of its Properties before Calcination. I once calcined some of the Lime-crusts; but they could communicate nothing to Water. Another Time I made the same Experiment; and they did communicate something, and yielded Lime-water; perhaps because they were collected off the Water standing on the Lime; and so might contain some Parts of the not exhausted Quick-lime. I remember also, that *Van Leuwenhoek* says, old Lime-rubbish may, by Calcination, be rendered Quick-lime. And I found, that some exhausted Chalk-lime, upon Calcination, became really Quick-lime again, and afforded several Lime-waters. If this constantly hold, it is not improbable, that, by repeated Calcinations, all the Quick-lime may at last be rendered dissolvable in Water. But whether the Crusts which filtered Lime-water throws up, may by Calcination be again reduced to Quick-lime, I cannot yet determine. (That they may thus be reduced again to Quick-lime, Experiments have since sufficiently evinced).

III. By Article xiii. of the just now published *Essays and Observations physical and literary*, it appears, that my good Friend Dr *Whytt*, to discover whether he had not been mistaken concerning the Strength of different Lime-waters, thought it necessary to make some new Experiments, and publish them; whereby he has endeavoured to prove, "That Lime-water acquires a considerable Addition of Strength, by being poured on Quick-lime newly taken from the Fire; and that the first Water got off Quick-lime, is sensibly stronger than the fourth and succeeding ones, &c." And as his Design was laudable, and Example worthy of Imitation,

(*b*) Vid. *Ess.* p. 76.

I have likewise made a Variety of new Experiments, as well as repeated not a few old ones. Yet having still the Misfortune to differ from the Doctor, I hope to be allowed to lay the Reasons before the Reader, and to leave it to him to determine the Controversy. In

§ 1. The first Argument for the different Strengths of Lime-waters, is taken from hydrostatical Experiments. For by weighing three different Lime-waters in a Copper Vessel of one thousand three hundred and fifty-five Grains Troy Weight, and containing exactly a hundred cubical Inches, the Doctor found, that this Vessel contained of our Fountain-water (a) 25,320 Troy Grains; of a very weak Lime-water, (b) 25,356 Grains; of a strong single Lime-water, (c) 25,397 Grains; and of a double Lime-water, (d) 25,457 Grains. So that the specific Gravity of (a) is to that of (d) as 185 to 186; whereas, by former Experiments (c), it was as 168 to 169, or about a seventh Part more. But the great Mr *Boyle*, after many Trials, having determined the Weight of a cubical Inch of Water to be two hundred and fifty-six Troy Grains (d), an hundred cubic Inches must have weighed, according to his Balance, twenty-five thousand six hundred Troy Grains; that is, a hundred and fifty-three Grains more than the double Lime-water (d). But,

Not to insist on specific Gravities, the Experiments are otherwise defective; for I no where say, that calcined Oyster-shells yielded me five hundred and twelve, or five hundred and twenty times their Weight of Lime-water. Stone Quick-lime ought to have been taken; which must afford more than the Shells can; since the Doctor determines the true Proportion of Stone Quick-lime to the Water to be as one to ten; but of Shell Quick-lime, as one to seven (e). Besides, these Lime-waters ought to have been treated as were the Lime-

(c) *Ess.* p. 40.

(d) *Vol.* 5. p. 19.

(e) *Ess.* p. 20. & 33.

waters, § iv. below ; and not only the Crusts they yielded, weighed ; but also the specific Gravity of each examined, after all the calcarious Crusts were separated : For if then they differed proportionally still, it is plain the Difference must be owing to some heterogeneous Substance adhering to the Shells. And

(a) That this may be the Case, is pretty probable, if any Regard is due to the most accurate Experiments that I could make. For a Glass Flask weighing eight hundred and two Troy Grains only, which is not fully thirteen and a half Drams, contained of Water eight thousand nine hundred and twenty such Grains ; but of the same Water, wherein about a seventh Part of its Weight of Pit-coal white Ashes had been infused for two or three Days, being filtered through gray Paper, eight thousand nine hundred and forty-six Grains ; though it diluted only an Infusion of Violets ; and in Colour, Taste, and Smell, differed not from Fountain-water. Again,

(b) I infused also a hundred Grains of flaked Stone Quick-lime (which contains about forty Grains of Water) in seventeen Gills of common Water ; for so much only my Bottle could hold : Ten Days after, I filtered it ; and found, that my Flask contained as much of it, as it did of the first Infusion of a Pound of flaked Quick-lime in twelve Pounds of Water, *viz.* eight thousand nine hundred and forty Grains ; that four Gills of it yielded fully eleven and a half Grains of Crusts ; the filtered Water not differing from common Water in specific Gravity when weighed in the Glass Flask ; and that there remained of the Lime, when well dried, ninety-five Grains ; as if five Grains only had been dissolved in more than sixty-three Ounces of Water ; which might yield forty-eight Grains of Crusts. See this accounted for, *p.* 10.

(c) I also put into four Gills of Fountain-water so much recent Quick-lime, that when I filtered it the Day after, I could obtain only a Gill and an half of Lime-water. So that for one Part of Quick-lime, there could be no more than three Parts of Water ;
for

for I did not weigh the Lime. Yet this Lime-water, filtered after it had stood several Days, yielded only four Grains of Lime-crusts. In a Word, for one Part of recent Stone Quick-lime, whether I took five, fifty, or five hundred Parts of Water, the Lime-waters did not sensibly differ in specific Gravity, nor in the Quantity of Crusts which they threw up, when examined with the greatest Accuracy that my Weights admit of. But

(d) Having prepared a quadruple Lime-water, by infusing into two Pounds of what I commonly make use of, three different Times, two Ounces of newly-calced Oyster-shells each Time, a Day always intervening; I found the Glass Flask contained of this filtered Lime-water, eight thousand nine hundred and forty-seven Grains; that is, seven Grains more than of the single Lime-water. Yet four Gills of it, after ten Days, did not afford half a Grain more of Crusts than the Lime-water (b); which cannot account for the increased specific Gravity. I therefore weighed in the Flask three Gills of this effete Lime-water, and found it about five thousand three hundred and sixty-eight Grains; that is, four Grains heavier than three Gills of Fountain-water. Is it not therefore more than probable, that the specific Gravity of the Doctor's Lime-water (d) is owing to something else than the Quick-lime, viz. to heterogeneous Substances dissolved in it; which do not, cannot increase its Strength? And the specific Gravities of the Doctor's Lime-waters (c) & (d), exceeding that of Fountain-water, much more than the Quantity of Lime dissolved in them can account for, seems to bring it to a Demonstration; as will more fully appear afterward. The Doctor adds,

“ The specific Gravities of these Lime-waters (b), (c), and (d), did not differ more than their Tastes. The first was weakest, and least disagreeable; the second was stronger; and the third stronger still, and somewhat pungent. Further, while the double Lime-water (d) in a few Minutes gave a Copper Colour to Silver, the

the weak Lime-water (b) produced no sensible Change upon it *."

One may easily be deceived in determining the Strength of Lime-water by the Taste (*f*): For if you fill three Glasses with the same Lime-water, and cause any one who thinks them different taste them one after another, he will readily say, that the first is weakest, and the last strongest and most pungent. And very lately, Mr *Joseph Black*, now very deservedly promoted Doctor of Medicine, and whose inaugural Dissertation *De magnesia alba* demonstrates an extraordinary Progress in Chymistry, and particularly his Knowledge of the Qualities of Lime-water, coming in while I was employed about the Lime-water (b) (*g*), I desired him to taste my common Lime-water; and he said it was very good and strong: Then I gave him the Lime-water (b), which he called remarkably stronger; but on tasting again the first, which appeared yet more pungent, he discovered the Reason of the apparent Difference, and that there really was none.

The weakest Lime-water that I use is so strong, that whoever tastes it two or three Times, as above directed, or keeps it in the Mouth for a small Minute or so, finds it pungent enough, yea and painful too, so as sometimes to complain that it excoriates. The first Infusion of Shell Quick-lime, indeed, is commonly more disagreeable than that of Stone Quick-lime; because, being not so thoroughly calcined, it communicates to the Water the foreign *Empyreuma*. And I cannot but think the Taste of the Doctor's double Lime-water (d) was in Part owing to this; because it gave a Copper Colour to Silver in a few Minutes, on account certainly of the remaining Sulphur; no Lime-water, nay nor Mortar made of Stone Quick-lime, having any such Effect on Silver. In

§ 2. The Doctor's next Argument is founded on the

* Art. p. 377.

(*f*) *Vid.* § 4. No. 1. above.

(*g*) p. 60. (b).

Colour of Gunpowder acquired by Claret Wine, when Lime-water in a certain Proportion is mixed with it. *Vid.* Art. p. 377. But as one Wine may differ from another in Fineness, Strength, Age, &c.; so in the Trials that I made, the Appearances did not always agree. Generally Claret admits of an equal Quantity of Lime-water, without precipitating: But if a double Quantity be taken, it becomes muddy and blackish, and lets fall a dark Sediment; and still more plentifully, if a triple Quantity of the Lime-water be used. Thus I had from a common Spoonful of Claret two Grains of dried Sediment, of the Colour of Chocolate.

As for the full Gunpowder Colour, a considerable Proportion of flaked Stone Quick-lime mixed with the Wine, did not give it that Colour. Did it any way depend on the incompleat Calcination of the Shells? That the Lime-water (b) is weaker than (c), is easily granted. But it requires more Accuracy in the Experiments clearly to demonstrate a remarkable Difference of Strength between (c) and (d), than its requiring two and about one third Tea Spoonfuls of the one, and only one and an half such Spoonfuls of the other, to give a Tea Spoonful of Claret Wine the full Gunpowder Colour. The Doctor adds in

§ 3. “Twenty Grains of Salt of Tartar, being mixed with eight Ounces and two Drams of the weak Lime-water (b), after it had stood five Days on the Lime, the Mixture became immediately white and turbid, and soon precipitated a white Powder; which being separated from the Water by Filtration, and dried, weighed two Grains (b):” Subjoining, that when double Lime-water which had stood eight Days on the Lime, was taken instead of (b), it afforded seven Grains; while the same Lime-water which had stood only twenty-four Hours on it, gave eight Grains of this same white Powder. “And it was observable, says he, that these three Lime-waters retained the Taste of the Lime, after being mixed with the Salt of

(b) Art. p. 378.

Tartar ; and this equally after Precipitation as before it (i)."

The Lime-water (b) must indeed have been very weak ; and I am much mistaken, if eight Ounces of it would have afforded three Grains of Crusts. And since, notwithstanding this, the Taste of the Lime remained in it after the Precipitation, it appears to be a Demonstration, that the white Powder proceeds *wholly*, or almost wholly, from the fixed alkaline Salt, and not from the Water : Which the Quantity of Powder the other Lime-waters yielded, notably confirm ; there not being a Grain of calcarious Crust in an Ounce of any Lime-water ; as the Experiments related above (k) make it visible to the Eyes. But

"What proves, says my Friend, that the Precipitation is *wholly*, or *almost* wholly, from the Waters, is, that the calcarious Matter precipitated is greater or less, in proportion to the Strength and Quantity of the Lime-water, but not in proportion to the Quantity of the Salt. Thus twelve Grains of Salt of Tartar, mixed with four Ounces of strong Lime-water, yield as much of this Matter, as the same Quantity of this Lime-water mixed with eighteen Grains of the Salt (l)."

Which appears to be an Attempt to prove, that we see not what we see. But at the same Time I must own, I do not see the Force of the Argument : For nothing is better known in Chymistry, than that in every Precipitation, the Quantity of the *Præcipitans* must bear a certain Proportion to the Quantity of the *Præcipitandum*. If the precipitating Power of four Ounces of Lime-water, in which there are not four Grains of Lime, be spent on twelve Grains of Salt of Tartar, as well it may, it is to no Purpose to add more ; much less might have sufficed.

It is also well known, that any fixed alkaline Salt dissolved in Water, precipitates some of its Earth in form

(i) p. 379.

(k) *Vid.* p. 20.

(l) Art. p. 379.

of a white Powder. If Potash precipitated the Lime, how could so much of it be found in Soap-leys, more than the double Lime-water (d) did contain, although all the hundred and thirty-seven Grains had been Lime (*m*)? This must be a new Sort of Precipitation. I cannot therefore think, that “these Experiments shew beyond Doubt, that double Lime-water may contain thrice as much Lime, as Lime-water made by pouring on Quick-lime five hundred and twelve times its own Weight of Water (*n*)”, if sufficiently calcined Quick-lime be taken. In the last, or

§ 4. We have three Experiments, shewing the Quantity of Crufts which three different Lime-waters yielded. N^o 1. was made by pouring on a Dram of fresh calcined Oister-shells five hundred and twenty Drams of Water; N^o 2. of a Pound of the same calcined Shells, and eight Pounds of Water: And of fifty Ounces of this N^o 2. after it had stood fifteen Hours, poured on nine Ounces of fresh calcined Oister-shells, was made N^o 3. After N^o 1. and 2. had stood twenty-four Hours, and N^o 3. nine Hours, all three were filtered through brown Paper, and sixteen Ounces of each put into a Bason by itself, and placed in a Closet pretty free from Dust, for nineteen Days. “After this, says the Doctor, I filtered the several Waters through brown Paper; and having collected the earthy Crufts, and dried them well, I found, that N^o 1. afforded very near four Grains; N^o 2. near twelve Grains; and N^o 3. rather more than thirteen Grains (*o*).”

(*m*) When above, p. 19. I made the Lime to be more than a third Part of the dry Salt obtained from Soap-leys, according to Dr Hales's Experiments, it was because, of the three hundred and twenty Grains of Salt remaining after the first Evaporation, there were but two hundred and thirty-six Grains, after it was divested of the Lime. But if the Waste on the Evaporations was of the Potash and Lime equally, there would be of the Lime in the four Ounces of Soap-leys, about fifty-five Grains; and if all was of the fixed alkaline Salt, only sixteen Grains of Lime; which is enough for our Purpose at present.

(*n*) Art. p. 379.

(*o*) Art. p. 379. & 380.

As for N^o 1. since too much Water was taken, and too little Time allowed to impregnate it, I pass it. But with regard to N^o 2. and 3. it is very observable, that the last afforded but one Grain of Crufts more than the second; a Difference no way proportional to their specific Gravities, as stated in § 1. According to which, seeing N^o 2. yielded twelve Grains of Crufts, N^o 3. should have yielded twenty-one Grains. Now, since, by my Experiments, four Gills, or some less than fifteen Ounces of Lime-water, after many Affusions, as well as of the first Water, yielded commonly between eleven and twelve Grains of Crufts; is it not evident, that the first Infusion contains not more Lime than many succeeding ones? And since the Doctor owns, “that Lime-water becomes effete as soon as it loses its earthy Matter (*p*);” and “that these three Lime-waters had, at the Time they were filtered, quite lost their Taste (*q*);” is it not also evident, that the Virtues and Strength of Lime-water depend entirely on these calcarious Crufts in their dissolved State? that Water can hold only a very small Proportion of these? and that whatever heterogeneous Substance may remain in it after the Crufts are thrown up, and increase its specific Gravity, it must be entirely inactive? But

“Observing, says the Doctor, that N^o 2. and 3. became turbid when mixed with Salt of Tartar, I added eight Grains of this Salt to twelve Ounces of these two Waters (which I had filtered into the same Bottle); and the white Powder that was precipitated when dried, weighed just one Grain and a half:” and then seems to conjecture, that it did proceed wholly from N^o 3. “In which Case, adds he, sixteen Ounces of it must have contained seventeen Grains of the earthy Part of the Lime, and N^o 2. only twelve Grains (*r*).”

But if he had mixed his Salt of Tartar even with

(*p*) *Ess.* p. 147.

(*q*) *Art.* p. 380.

(*r*) *Vid.* *Art.* p. 380. & 381.

common Water, he would have observed it become turbid, and precipitate the same white Powder. Yea, if he had evaporated the Solution again and again, and as often dissolved the dried Salt in Water; this white Powder would still have shewed itself, until all his Salt was reduced into it, as every Chymist knows (*f*). So there is not the least Foundation for the above Conjecture; and as little for the following Inference, *viz.*

“That the surest Way of knowing the Quantity of calcarious Earth contained in Lime-water, is, to evaporate it, as Dr *Langrish* did. And if it be objected to this, that all Water affords some Earth when evaporated, the Quantity of this may be determined by Experiment; though in many Waters it may well be neglected, on account of its Smallness (*t*).”

For till the Experiment is made, it remains undetermined. Nor is it always so small, as to deserve to be neglected, if we can rely on the Experiments or Testimony of famous Authors. For Instance, the learned *P. F. Hoffman* writes, that he found a Measure which contained only two Pounds of Rain-water, could contain of one of the *aquæ fontanæ domesticæ*, two Pounds and a Dram; and of others more, and of some less (*u*). That the Proportion the calcarious Earth or Lime bears to the Water, is more accurately discovered by the Crusts than by Evaporation, is still my Opinion; and the Doctor's Experiments confirm it. No matter what, or how much heterogeneous Earth, may be in the Water, or conveyed into it by the Shells, which Evaporation may discover; since the Virtues of Lime-water is no ways owing to it, but entirely to the Lime-crusts; which, by Evaporation, must be confounded with the foreign Earth; and so the Proportion they bear to the Water undetermined. I call them Lime-crusts, not only because all the Lime in the Water is soon turned into this Form in the free Air; but also be-

(*f*) *Vid.* Boerh. Chem. i. p. 640. *Hales's Exper. & Obs.* p. 9. &c.

(*t*) Art. p. 381.

(*u*) *Vid.* Hoffm. Obs. Phys. p. 127. or Rieger Introd. vol. i. p. 746.

cause by Recalcination they become Quick-lime, and can again impregnate Water.

To my reasoning from a known Property of every *Menstruum* (x), the Doctor cannot agree: For “the Water, says he, must *extract* the Virtues of Quick-lime, when weakened by long Exposition to the Air, or by many Affusions of Water; while Quick-lime fresh from the Fire, by a sort of *explosive* Force of its own, *quickly impregnates* the Water. Nor is it to be wondered at, that Quick-lime fresh from the Fire, should at first impregnate Water more strongly with its Virtues than it does afterwards. This is as easily conceived, as that boiling Water should extract more of the Virtues of Tea and Coffee than cold Water (y).”

But the Question here is not, Whether hot Water or cold extracts best the Virtues of Quick-lime? that is given up (z): Neither whether fresh Quick-lime sooner impregnates Water than Quick-lime long used? this I believe we are agreed in: But, Whether Water, if there be Quick-lime enough in it, and sufficient Time allowed, will not dissolve or extract as much of it as it can hold? And that this common Property of all *Menstruums* should be denied to Water, may indeed be wondered at. As for the *explosive* Force of fresh Quick-lime, I own I do not understand what it means, if it be not its growing hot, and falling down in Water. But since this does never happen to dry Quick-lime, the explosive Force belongs as much to the Water as to the Lime. Heat certainly increases or quickens the dissolving Power of Water in many Cases, yet not in all. Cold Water dissolves some Things which hot Water hardens. Cold Water dissolves as much common Salt as hot; and generally what hot Water dissolves of any Substance more than cold Water, it soon precipitates. But Heat has nothing to do here; especially since it forwards the Formation of the Crusts, and so

(x) *Vid.* p. 54.

(y) *Art.* p. 381. 382.

(z) *Vid.* *Ess.* p. 26. & 34.

seems rather to weaken Lime-water than make it stronger.

The Observation in *Ess.* p. 42. and cited above, p. 50. may be of more Use here than Tea and Coffee. For if double Lime-water standing but a few Days on the Shells, loses some of its Pungency and Strength, which weaker Lime-waters do not; this looks, as if, in the Hurry of the first Attack of the *Menstruum*, more of the Lime was taken up than it could retain. But this being soon precipitated, and discovered only by the Taste, very apt to be here deceived, it may well be neglected. And if the Difference of Strength be proven by Experiments, and the one appear evidently to be more detergent, or diuretic, or lithontriptic, &c. than the other, which I could never yet discover; I would attribute it to the dissolvable Part of the Lime's becoming less penetrating, or weaker, rather than to the first Water's taking up a greater Quantity of it; which seems inconsistent with the Experiments above related. He adds,

“ Upon comparing the Experiments § 1. with those of § 3. and 4. it appears, that the Difference between the specific Gravities of different Lime-waters and common Water, is much more than the Weight of the calcareous Matter contained in these Lime-waters. There must therefore be *something else* besides this earthy Matter, which Quick-lime communicates to Water by which its Weight is increased.” Granting the specific Gravities to be as stated above, § 1. this cannot be denied: But what this *something else* is, is the Question. “ Perhaps, continues the Doctor, Quick-lime may also, in some other Way unknown to us, alter the specific Gravity of Water. But whatever may be in this, it is evidently unreasonable to deny, that Lime-water is as much specifically heavier than common Water, as the hydrostatical Balance, or other accurate Experiments shew; because we cannot account for the Excess of Gravity from any thing we know of the Contents of Lime-water. This is no less unphilosophical, than if

if one was to doubt of *universal* Gravity, because Philosophers have hitherto attempted in vain to account for it (a)."

The specific Gravity of any Lime-water, is of no other Consequence in the present Question, than as it is adduced to prove, that its Strength is proportional to it; and "that double Lime-water may contain thrice as much Lime, as Lime-water made by pouring on Quick-lime five hundred and twelve times its Weight of Water *." But that no such Consequence can be deduced from it, sufficiently appears already. For whatever this *something else* is, it is plain the Strength of Lime-water does not depend on it, being effete and tasteless so soon as the calcarious Crusts are separated from it.

Indeed, if ninety Grains of half-calcined Shells be infused in ninety-six Ounces of Water, in an open-Vessel, for ninety-two Hours; there may not be in sixteen Ounces of such Water above four Grains of Lime. But seeing a smaller Quantity of Stone Lime-water yielded me near twelve Grains of Crusts (b), it cannot be inferred, that double Lime-water contains thrice as much Lime as the former, if rightly prepared. But in order to discover what the above *something else* is, the Remainder of the calcined Shells ought to have been weighed, and the specific Gravity of the effete Water also examined. For if such Waters be not specifically heavier than Fountain-water, it must puzzle even a Philosopher to prove, that the Quick-lime communicated any thing to them, besides what was thrown up in Crusts: But if specifically heavier than Fountain-water, the Cause is easily discovered, to wit, an inactive Earth. And no hydrostatical Experiments can shew, that the Virtues or Strength of Lime-water depend on it.

Quick-lime fresh from the Fire, by its explosive Force or Heat, may indeed alter the specific Gravity of Water; that is, diminish it: But that it can increase it,

(a) Art. p. 383. 384.

* Art. p. 379.

(b) Vid. p. 60. (b).

without communicating, of its own Substance, what does not proportionally increase the Bulk of the Water, and diminish its own Weight, appears to be so inconsistent with the known Laws of *universal* Gravity, that no Experiments can prove it. And if any such Experiments be alledged, I leave it to the Reader to determine, whether such Inferences from them be not more improbable, if not more unphilosophical, than that there might be some Imperfection in the Balance, Measures, Weights, &c. or Mistake in the Experiments. But the Doctor's *something else* is quite different.

“As Lime-water, says he, after its earthy Part has been precipitated by an alkaline Salt, continues to taste strongly of the Lime; it follows, that, besides this Earth, it contains *some more active and subtile Part*, to which its Taste and Virtues are chiefly owing. For we know, that the calcarious Matter of Lime-water is perfectly insipid, and void of any other Virtue than what all absorbent Earths possess. This active and more subtile Part of Lime-water seems to be separated from its Earth by the alkaline Salt, which strongly attracts and embraces it. And hence Lime-water, mixed with Salt of Tartar, does not lose its Taste of the Lime by being exposed to the open Air. Does not a Solution of fixed alkaline Salt in Water poured on Quick-lime, separate this subtile active Matter of Quick-lime from its earthy Part, by strongly attracting it? And do not Soap-leys consist of Water, and a fixed alkaline Salt, united with this active Part of Quick-lime, without *any*, or *almost any*, of its earthy Part (c)?”

That a fixed alkaline Salt does not precipitate all the earthy Part of Lime-water, is proven above (d); as also that it is to the calcarious Crusts, in their dissolved State, that its Taste and Virtues are owing; they being the most subtile and active Part of the Quick-lime, while dissolved in the Water; and after their Formation, capable, by Recalcination, to be so subtilized, as again

(c) Art. p. 383.

(d) p. 20.

to impregnate Water. What becomes of the Doctor's *more active* and *subtile* Part, when the calcarious Matter is turned into Crusts? Surely there is nothing *active* then remaining in the tasteless and effete Water. "But we know, that the calcarious Matter of Lime-water is perfectly insipid, &c." And is not the same true of the Water, when freed of this calcarious Matter? That the calcarious Matter, in its solid State, is perfectly insipid, has nothing singular in it. So is every solid Substance, especially Minerals, undissolved. *Sal nihil agit nisi solutum.* But in its dissolved or liquid State, if I may so call it, it is certainly most subtile, yea more so perhaps than any Salt. For we know also, that it is so lodged in the Pores of the Water, as neither to diminish its Transparency, nor increase its Bulk; that it rises in Water, and yet increases its specific Gravity. What more subtile than this can Quick-lime communicate to Water? That the alkaline Salt is united to this in Soap-leys, is proven above, p. 65. and evident to the Sight, if equal Parts of a Solution of Potash and Lime-water be mixed; no Crusts being then formed on the Surface. Besides, to my Friend's two Queries, Quick-lime being altogether earthy, without communicating *any*, or *almost any*, of its earthy Part, can communicate nothing, or almost nothing, to a fixed alkaline Salt, no more than to Water. A Negative therefore only is due to the two Queries.

"Enough, it may perhaps be thought more than enough, has been said to shew, that the Strength of Lime-water is very different, according to the different Quantities of Water poured on Quick-lime. However, I must be allowed to say, that this Point, which has been disputed by my good Friend, is of that Consequence, as to deserve to be fully cleared up; since to such as drink Lime-water with a View to the Cure of the Stone, it is of no small Importance to know how it may be prepared, so as to have the surest and speediest Effects (e)."

(e) Art. p. 384.

I leave it to the Reader to determine the Question disputed betwixt us ; and at the same time own, that it deserves to be fully cleared up ; but cannot think, that it is of no small Importance to such as drink Lime-water for the Stone, to prepare it his Way, even granting the Difference of Strength he pleads for. For allowing his double Lime-water to be twice as strong as common Lime-water, and that the first Infusion is sensibly stronger than the fourth and succeeding ones ; this Defect is easily supplied, by increasing the Dose ; which must be always more safe, and perhaps also more efficacious ; much of the Virtues of Lime-water depending on the pure Element ; “ as we find even the hardest Rocks yield to common Water (f).” And here I cannot but notice a pretty remarkable *Phænomenon* which occurred when I was making some Experiments on the lithontriptic Virtue of Shell and Stone Lime-waters.

April 20. 1753, I took two Fragments of a very hard *Calculus*, weighing forty-four Grains each, and much of the same Figure. One I put into a little square Phial with a wide and not quite round Mouth ; and the other into another Phial of the same Shape, but with a straiter and regularly-round Mouth. This I shall call B, and the former A. And having poured into A a Gill and a half of Shell Lime-water, and as much of Stone Lime-water into B, I set them in a Window ; B being very closely corked ; but not A, by reason of its ill-shaped Mouth. For several Weeks their Appearances were much the same ; only, more Access being allowed to the Air in A than B, the Crusts soon covered its Water ; while there was none on B. But looking on A *June* the 30th, the Fragment seemed (as if it had been Quick-lime) to have fallen down into a very white *farina*, or rather into Snow ; and I thought it was all dissolved : But on taking it out, I found it had lost but four Grains of its Weight, its very bulky Appearance notwithstanding ; the rest of the Fragment being as hard as ever. B continued solid for several

(f) *Ess.* p. 23.

Months, and never fell down. I repeated this Experiment twice since, and the *Phænomena* were much the same. What appears most remarkable, is, that this Change happened only to A; and never in less Time than two Months; and so, long after the greatest Part of the Lime, if not all, was thrown out. Is it to be ascribed to the Shells? to the Air? or to elementary Water?

But if it be proper to increase the lithontriptic Power of Lime-water, this may be done with Safety, by taking *Alicant* Soap along with it; or, with more Danger, by adding to it less or more of an alkaline Salt. Either of which may save the Trouble of calcining great Quantities of Shells, for every four or five Pounds of Lime-water. I said Shells, because, according to the Doctor's Computation, the lithontriptic Power of double Shell Lime-water, to common Stone Lime-water, is as forty-five to ten (g). If this Calculation displease the Mathematicians, I cannot help it; nor will I argue for or against them. "Any one who doubts on whose Side the Truth is, may easily satisfy himself." I shall only add, that, notwithstanding the many Experiments that I, as well as my Friend, have made, I have not seen Cause to retract any thing advanced in the former Edition of this Discourse. And

To conclude: The Experiments which I made, are simple, and may easily be repeated by any body, without the Trouble of Lamp-furnaces, digestive or other artificial Heats, statical Balances, or the like; and if it be found, that they cannot support the Inferences which I have drawn from them, I am willing to give them up.

*Errare est hominis, sed non persistere: sæpe
Optimus est portus vertere consilium.*

(g) *Vid. Est. p. 154. and Art. p. 376.*

A P P E N D I X.

HOW far Lime-water may be proper even in acute Distempers, I cannot yet determine. Only I have found it safe in feverish Colds, and notably successful in rheumatic Pains; and its diluent and diuretic Qualities seem to make it probable, that it may prove more useful in Fevers, than is at present believed: Which the following Abstract of two Letters from Mr *Robert Menzies*, M. C. confirms; who writes thus.

A Young Man of twenty-two, who had an Ague in *March* 1751, and continued still valetudinary, was, in *August* following, seized with Pains in his Bones, Lassitude, Nausea, &c.; and on the ninth Day with a cold Fit; after which he turned hot and feverish, and I was sent for. I gave him an Ipecacoan Vomit, which brought up a great deal of tough Phlegm and Bile; yet he continued very sick, feverish, and weak. An Infusion of Poppy-heads and Spear-mint settled his Stomach a little; but a violent Looseness came on, and continued till next Night, accompanied with violent Colic Pains and Gripes. Next Morning he complained of Pains in his Loins, Groins, and about the *Penis*, of a Numbness in his Thighs and Nausea, and made little or no Urine; which made me suspect a *Nephritis*, and I determined to blood him. But seeing the Blood so poor and thin as scarcely to colour my Finger, I soon stopt it; and though I did not take above three Ounces, he fainted, was more weakened by it, and his Pains as violent as ever. And knowing the good Effects of Lime-water in stopping Fluxes, and increasing Urine, I had Recourse to it. Its being generally believed to be much upon the Alcaline, and apt to corrupt animal Substances, made me give it with Caution, and in small Doses. Accordingly, at twelve I gave *Aquæ calcis* unc. i. & *Laud. liq.* gut. iv. after which his Pains began to abate. At two after Noon, I gave *Aq. calcis* unc. ii.

without any *Laudanum*; and, his Pains still abating, at four I gave four Ounces. He was quite free of Pain at five; fell into a sound sleep at six; I left him sleeping at eight, with Orders for him to drink the Lime-water when he wakened. He drank two Pounds of it that Night, and made Urine easily and plentifully. Next Morning his Fever was easier, his Appetite a little better; and before Night he thought himself so well, that he would take no more of this four Drink, as he called it. However, about three Days thereafter he fell ill again, had the same Complaints, excepting the Looseness and *nephritic* Symptoms, and begged more of his four Drink; which I readily granted, and made him drink three Pounds of it every Day. In two Days Time the Fever left him, and he found himself easy; but continued to drink that Quantity daily for two Weeks, to prevent a second Relapse.

About the Time my Patient relapsed, other three of my Patients were taken ill. The Symptoms being the same with those he then complained of, I followed the same Method with them; and all of them were free of the Fever before the third Day after using the Lime-water, though one had been four Days in the Fever, another five, and the third eight, before they began it.

I was afterward called to a Drover in *Glenlyon*, a middle-aged Man, ill of the same Fever. He was so tormented with a Strangury and Flatulencies, as sometimes to fall into a *deliquium animi*. After emptying his Bowels, I gave him *Aqua calcis*, and half a Grain of *Opium*. He sweat a little after it; and drinking near a Bottle at a Draught, made Urine plentifully, and slept soundly. Three Days after drinking the *Aqua calcis*, his Urine deposited a Sediment. He continued to drink it to three Pounds daily for fourteen Days. I had in all nineteen Patients in this Fever; eighteen of which I treated the same Way; and all of them recovered in three or four Days after drinking the *Aqua calcis*. But a Woman whom I could by no means persuade to take it, died the twenty-second Day of the Disease *comatous*.

I was at a great deal of Pains to collect the History of this Disease from such as had taken no manner of Medicines; and found, that for the first six or seven Days after being confined to Bed, the Fever was pretty acute, their Skin dry, Thirst great, Tongues crufted with *Aphthæ*, the Belly commonly bound, and Urine high coloured. Then they began to sweat, without being in the least relieved by it; and the Fever became low, accompanied with a Drowfiness. Betwixt the fourteenth and eighteenth Day they were often delirious; and then perhaps a *Coma* carried them off; or turning lighter, till between the twenty-eighth and thirty-second Day, the Fever left them, and they recovered.

In the following Winter, a Man who laboured under Pain in his Breast, with Straitness and Anxiety, a violent Headach, accompanied with Redness in his Face, and a short Cough, asked my Advice. I recommended to him, perhaps rashly, the Lime-water; and in less than two Hours after he began to drink it, the Symptoms considerably abated; his Pulse from being very soft and small, became pretty full and strong; and next Morning his Urine deposited a plentiful white Sediment, and stained the Sides of the Glass. However, though his Complaints were mitigated, they were far from being gone: So I advised him to call a Physician; who, being apprehensive that the Lime-water might prevent Expectoration, allowed him no more of it, but followed his own Method. In less than twenty-four Hours after giving over to drink the Lime-water, his Urine turned clear and limpid, without either Sediment or Scum, though his Complaints decreased apace, and he continued pretty calm, but sick, for four Days; when his Urine began to suspend a light Cloud, and the next Day separated a plentiful white Sediment, which it continued to do for some Days, till all his Complaints were gone. As the last *Crisis* was by Urine, and not either by Sweating or Expectoration, was it not probable, that had the Lime-water been continued, the Disease,

case, which appeared to be a *Peripneumonia notha*, would have been sooner overcome?

We have a Fever among our lower Sort of People, which began in *July* last. It is accompanied with Vomiting, Purging, and great Sickneſs; and ſometimes ends in a *Peripneumony*, but more commonly in an *Absceſs* of the *parotid*, *axillary*, or *inguinal* Glands. The Lime-water does not ſucceed ſo well here as in laſt Year's Fevers. Yet, though it does not carry off the Diſeaſe in a few Days, it moderates it; and when taken in Time, it has not failed to make the Urine deſiſt a Sediment, and prevent the bad Symptoms which might otherwiſe enſue.

I have, with very good Succeſs, given Lime-water to Children troubled with vomiting of curdled Milk, Gripes, and green Purging, after other *Absorbents* were adminiſtered to little or no Purpoſe. I have alſo frequently given it as an *Anthelminthic*. It expels the long round Worm pretty well. I had one Patient with the *Ascarides*, which occaſioned a frequent *Teneſmus*, and twice an *epileptic* Fit. I gave Injections of Lime-water, but with very little Succeſs. I then gave Oil Clyſters in which ſome *Sal Martis* was mixed; this carried them away in great Plenty, and cured the Patient.

I am, &c.

There is a Letter in the *Scots Magazine* for *Auguſt* 1752, p. 395. by *J. M.* attesting the anthelminthic Virtue of Lime-water. And though Mr *Menzies* did not find in Lime-water injected an immediate Cure, yet I think there is Reaſon to believe, that if the Patient had firſt taken a Bottle of it, and an Hour or two after received the Injection, and theſe repeated once and again, it would have both killed and alſo expelled that

that Kind of Vermin; but let Experience determine.
For,

*Usus & impigræ simul experientia mentis
Paulatim docuit pedetentim progredientis.
Namque aliud ex alio clarescere corde videbant
Artibus, ad summum donec venerat cacumen.*

F I N I S.



that kind of Veneration; but let Experience determine.

The first of these is, that the
 Veneration which is paid to the
 dead is not a necessary consequence
 of the Christian Religion.

THE SECOND



Alston, Charles

A dissertation on Quick-Lime and Lime-Water

Edinburgh 1754

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